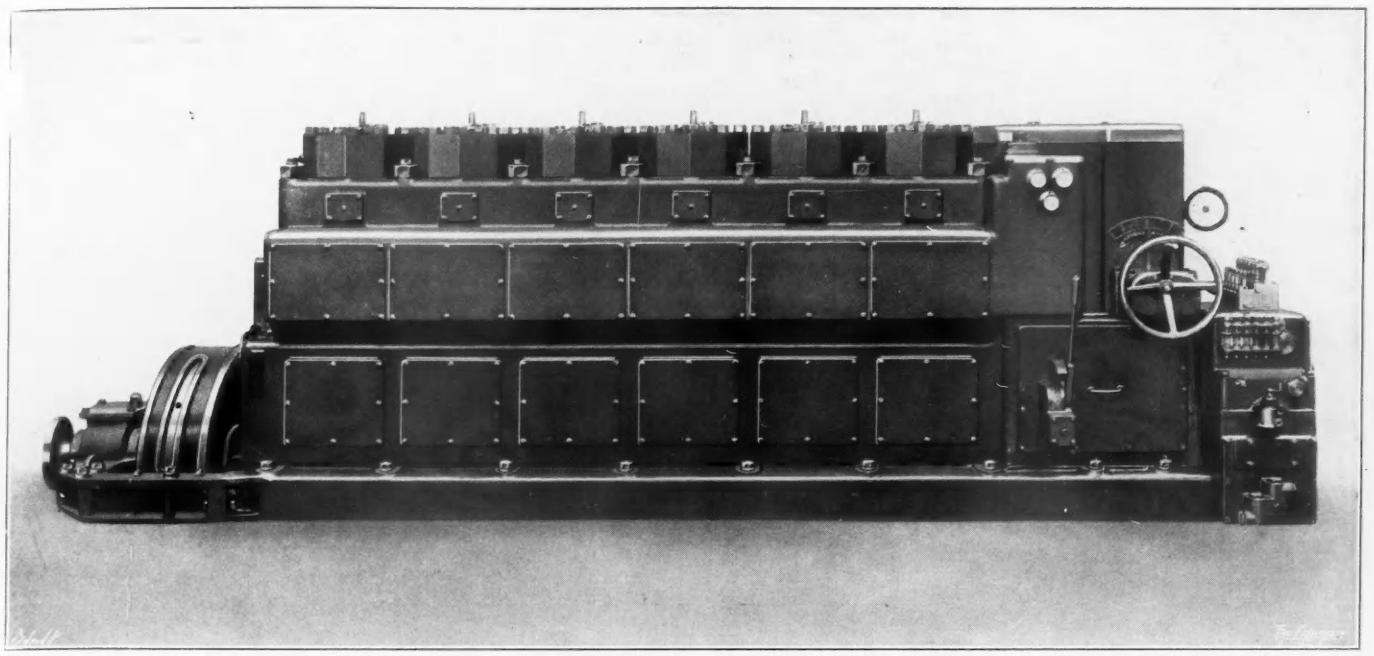
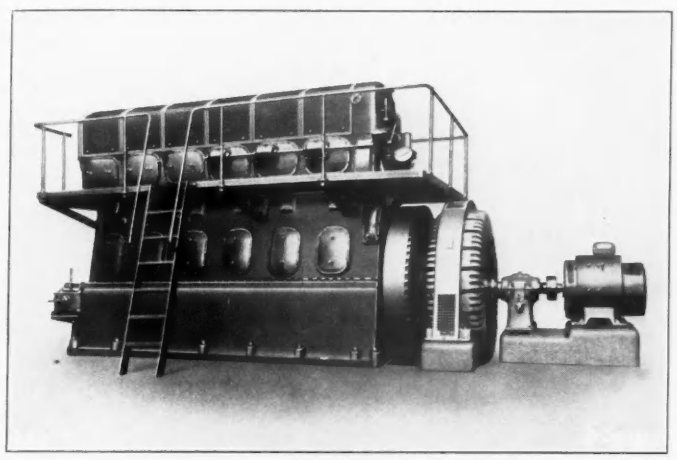
Pencil Portrait No. 13

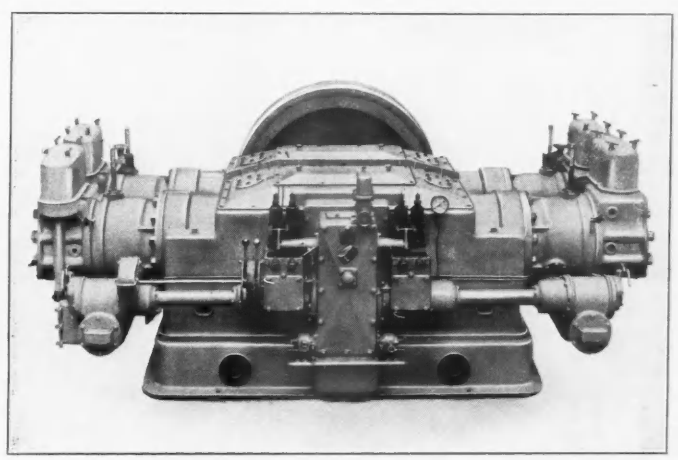
ENGINEER VICE-ADMIRAL SIR HAROLD BROWN, K.C.B.

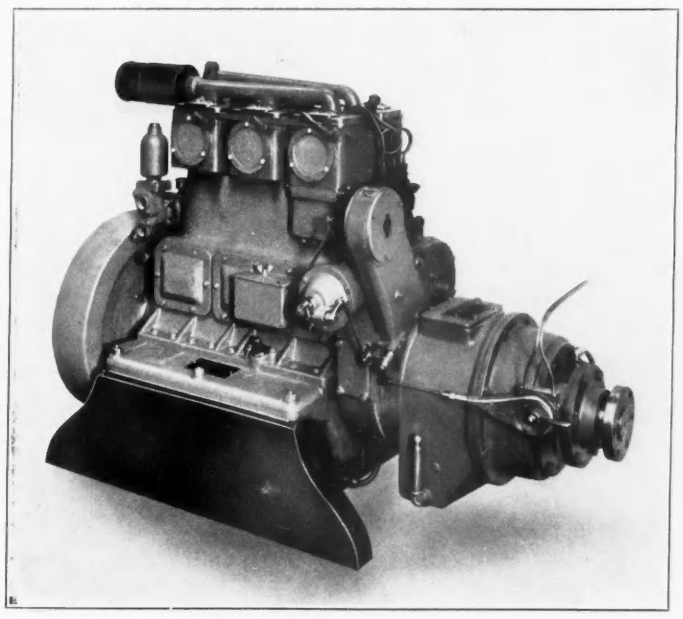
DRAWN FOR THE ENGINEER BY ELLIOTT & FRY

OIL ENGINES AT THE OLYMPIA EXHIBITION









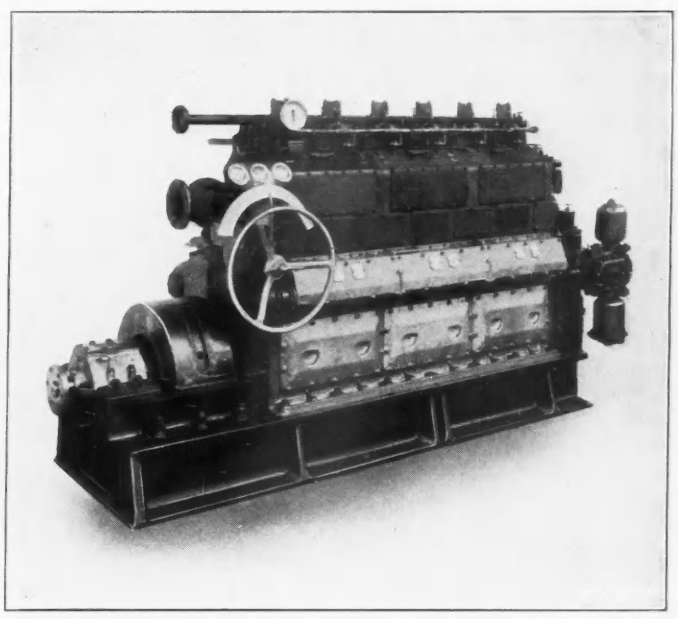


FIG. I—SIX-CYLINDER 330 B.H.P. MARINE REVERSING ENGINE—CROSSLEY

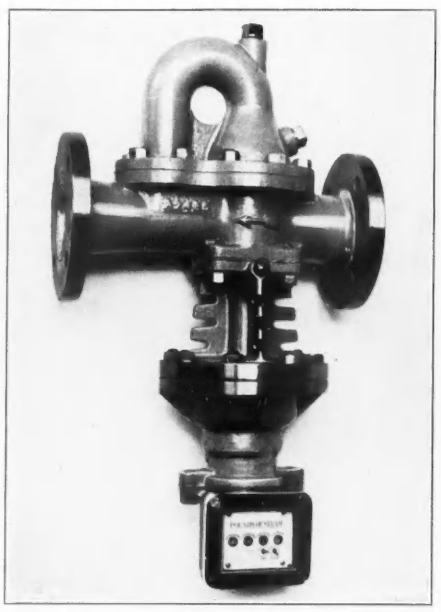
FIG. II—SIX-CYLINDER 582 B.H.P. ENGINE AND GENERATOR—ALLEN

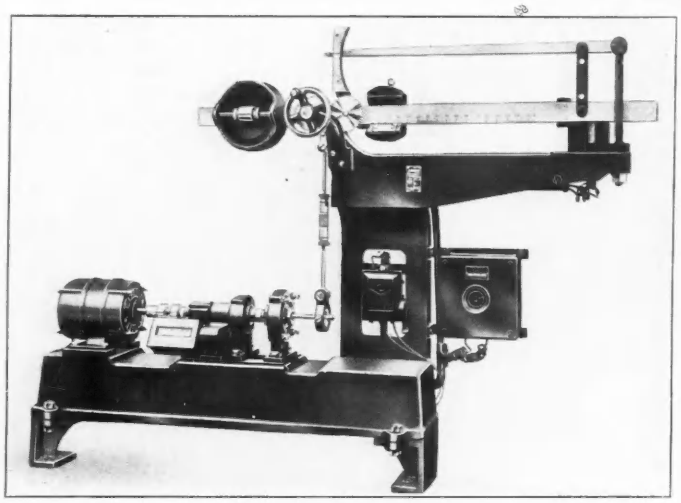
FIG. III—FOUR-CYLINDER 312 B.H.P. VIS-A-VIS ENGINE—BRUSH

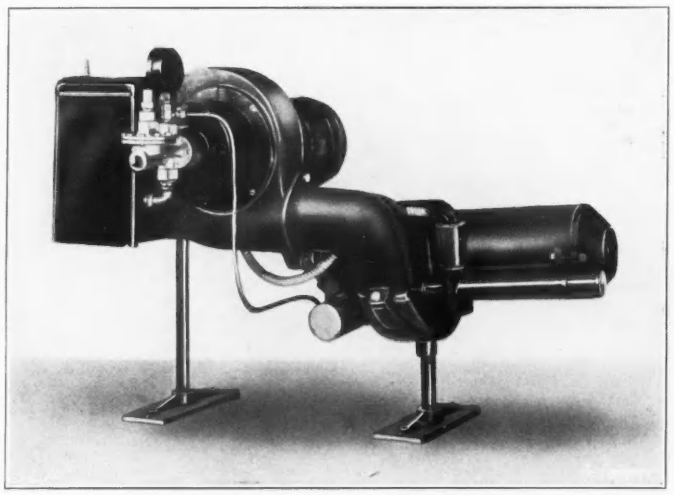
FIG. IV—THREE-CYLINDER 30 B.H.P. MARINE ENGINE—RUSSELL

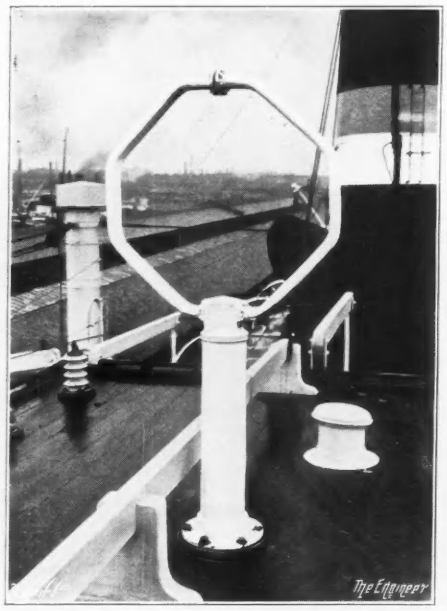
FIG. V—SIX-CYLINDER 300 B.H.P. MARINE ENGINE—PETTERS

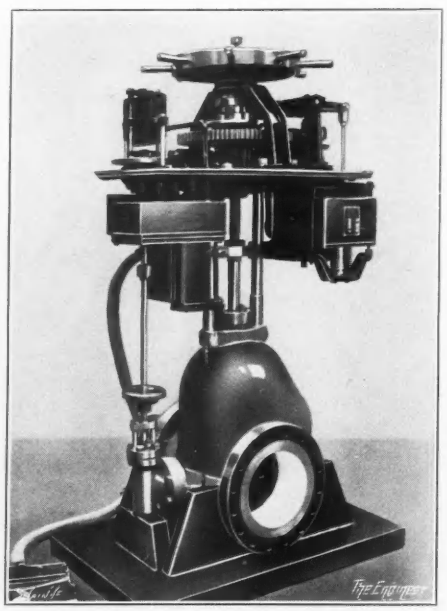
INSTRUMENTS AND TESTING AND CONTROL DEVICES AT OLYMPIA











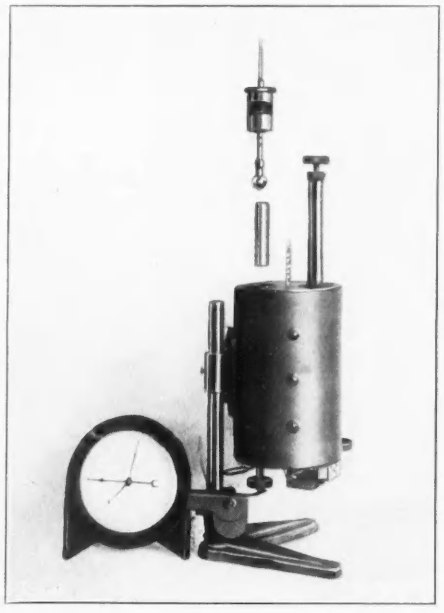


FIG. VI—NAVIGATIONAL RANGE FINDER—BARR & STROUD

FIG. VII—"TUREEN" TOP COMPASS—LILLEY

FIG. VIII—ROTARY SHUNT STEAM METER—KENT

FIG. IX—FATIGUE TESTING MACHINE—AVERY

FIG. X—"LUMASTAT" FITTED TO OIL BURNER—RADIOVISOR

FIG. XI—DIRECTION FINDING AERIAL—GAMBRELL

FIG. XII—"HANDOR" VALVE WITH ELECTRIC OPERATING GEAR—BABCOCK

FIG. XIII—BALL AND BUCKET VISCOMETER—DOBBIE

THE ENGINEER.

Engineering and Marine Exhibition at Olympia.

Supplement Number One.

Engineering and Marine Exhibition at Olympia.

THE fourteenth Engineering and Marine Exhibition at Olympia, London, opened yesterday, September 16th, and will remain open until October 2nd. The last Exhibition of the series was held two years ago and was known as the "Shipping, Engineering and Marine Exhibition." Gradual changes which have come about in the character of the exhibits have led to the title being changed to its present form. For the first time welding machinery and equipment appear as a special section of the Exhibition, and are represented by a large number of exhibits. Equally well represented are foundry machinery and products which are included in the Foundry Trades Section of the Exhibition.

No mention of the Exhibition would be complete without a reference to Mr. F. W. Bridges, the veteran organiser of the series. Following upon some months during which there are no meetings of the institutions, the Exhibition forms one of the first of the events in the social and technical calendar of the British engineering world. It is to Mr. Bridges' credit that this is so, for not only has he gathered together an extremely interesting selection of exhibits, but he has taken steps to ensure that societies and institutions can arrange for meetings to be held at Olympia within the Exhibition period.

As for the exhibits themselves, the oil engine manufacturers are, as at the last biennial Exhibition, particularly well represented. The stands taken by the oil engine makers are not only strong numerically, but also in the technical interest which is to be found in many of the new designs shown. Whether for marine or industrial use, a comprehensive range of oil engines is shown which well illustrates the advances made in recent years. Although, perhaps, steam engineering is not so well represented, there is more than enough to show that considerable advances continue to be made. The steam exhibits, in fact, embody technical developments which indicate that this older form of prime mover is far from suffering an eclipse. The makers of machine tools exhibiting at Olympia are, unfortunately, few, since the majority of the British machine tool makers are affiliated to the Machine Tool Trades Association, which limits participation in exhibitions other than those arranged by itself. However, those machines which are shown are interesting, even though they cannot be regarded as truly representative of the British industry. Electrical machinery is, we think, not well represented, except in the Welding Section of the Exhibition, wherein are shown many forms of those welding equipments which are now being increasingly used in all branches of the engineering industries. The final opinion as to the merits of the Exhibition we must leave to our readers, who, after perusal of these pages and after visiting the Exhibition, will be qualified to pronounce judgment. As a guide to those visiting the Exhibition and for the interest of those unfortunately unable to spare the time, we print in this Supplement a description of some of the exhibits. Another Supplement devoted to the same purpose will accompany our next issue, and descriptions of the exhibits will also be included in the pages of the accompanying and following issues.

Reference may also be made here to the Pencil Portrait. Its publication with this issue is particularly appropriate, in that Engineer Vice-Admiral Sir Harold Brown is Honorary President of the Exhibition.

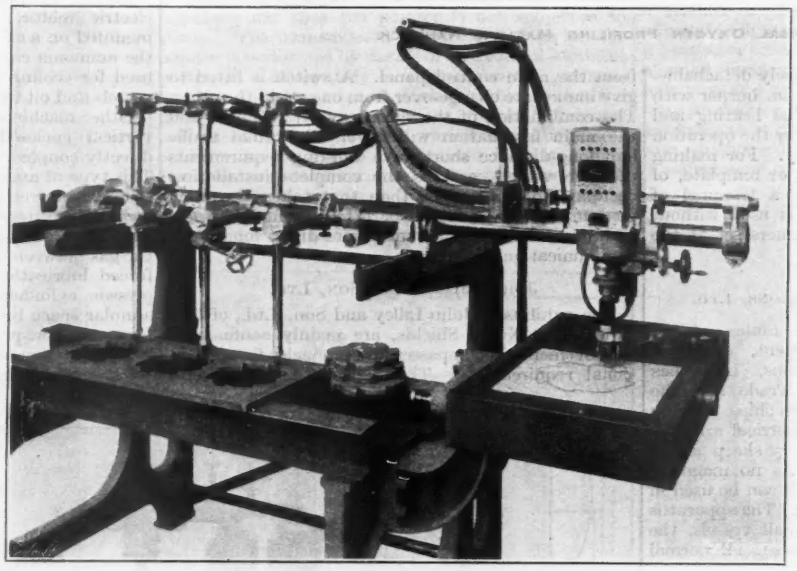


FIG. 1—TRIPLE-HEAD OXYGEN CUTTING MACHINE—HANCOCK

HANCOCK AND CO. (ENGINEERS), LTD.

Two novel forms of oxygen blow-pipe cutting machine are exhibited by Hancock and Co. (Engineers), Ltd., of Progress-way, Croydon. They are illustrated in Figs. 1 and 2.

The first, it will be seen, has three burners and is intended for repetition work on medium-sized parts. It will, for instance, cut three parts simultaneously measuring within 24in. by 12in., make three cuts each 26in. long and circles up to 12in. in diameter. The cutting burners are linked together on a common guide rod and are guided round the desired profile by the power-operated tracer wheel seen on the right. This wheel can be guided by hand round an outline on a drawing, as shown in the illustration, or made to follow the contour of a strip metal or wooden template.

The patented suspension of the moving parts ensures practically frictionless movement with rigid support for the burners, whilst the space which the machine occupies is little more than the area covered by the three burners and template. The setting up is both speedy and simple. Each burner has independent height, transverse and longitudinal adjustment, and, in addition, two or all the burners can be simultaneously moved in a longitudinal direction without moving the electric tracer when running in at the start of the cut. All the burners have a single control for both heating and cutting oxygen, so that they will start up and stop simultaneously. Stop valves are provided if it is desired to cut out any of the burners. The electric tracer is driven by a constant speed electric motor, A.C. or D.C., with infinitely variable gear for speed control. Interchangeable drives are provided, so that the machine can be quickly converted from template to drawing operation, or *vice versâ*. Circle and straight line cutting is carried out without templates or guides.

The Auto-Simplex cutting machine shown in Fig. 2 is a general service machine, which is described by the makers as being capable of producing single parts or just a few off from a drawing, accurate and intricate parts in quantity from a wooden template, a channel template, or a strip aluminium template. It can be used for following round a design marked out on the plate itself, for cutting circles up to 40in. diameter, and for cutting straight lines. The machine is really one of the makers' standard Simplex type, with the addition of a twin annular cutting head constructed as follows:—The standard 2in. burner is removed, and in its place is fitted a 2in. vertical tube which supports a mechanically rotated hollow shaft. The shaft carries at the lower extremity a twin "V" slide holder, into which are fitted two adjustable "V" slide bars. These slide bars support two cutting burners, one with a vertical nozzle and the other with a nozzle adjustable for angular cutting up to 45 deg. The oxygen and gas supplies for both burners pass through two tubes up the centre of the shaft, together with the two Bowden oxygen controls for the burners, and thereby any possibility of entanglement is avoided. The shaft is rotated by means of an independent constant-speed electric motor through a variable-speed gear, telescopic shaft, universal joints, and totally enclosed worm and worm wheel.

A steering control for rotating the vertical hand-guided tracer from the front of the machine is fitted with a graduated angle plate marked in five-degree divisions, and an adjustable index line for cutting purposes. The index line carrier is fitted with a spring plunger which engages with the positions 0 deg., 90 deg., 180 deg., and 270 deg. on the angle plate. The corresponding movements of the tracer wheel are from front to back, from left to right, from back to front, and from right to left. To ensure that the machine will travel in absolute straight lines in these four positions, the rotary control also operates two magnetic brakes, one on the tubular carriage and one on the rack rails. The operation is synchronised by the use of two mercury switches operated by a cam on the control shaft. For controlling the machine in other directions the magnets are cut out. If it is desired to make straight cuts at right angles to each other, but not square with the machine rails, it is only necessary to set the index carrier to the desired angle and the spring-locating plunger will operate in the four right-angular positions from this point. For guiding the burner along a line marked out on the plate the spring plunger is released and the tracer can be steered in any direction without restriction.

The machine is fitted with two motors, one for driving the standard tracer head and the other for driving the annular head. The motors have independent reversing switches, the one for the tracer having two, one at the front and one at the back. A change-over switch transfers the supply from the tracer to the annular drive motor, and *vice versâ*. By the use of this switch in conjunction with the reversing switches, it is possible to control the movement of one of the annular head burners from a straight line to circle, and *vice versâ*, without stopping the cut. This operation can be carried out at a bevel as well as vertically. The annular head is easily detachable, and can be replaced by a standard 2in. burner with or without bevel cutting head. The heating and cutting oxygen control is adaptable for the operation of one burner or two simultaneously. For making dual cuts operating from a drawing or template, of circles up to 24in. diameter using a trammel of straight lengths, the annular head is used without the annular drive, and with the burners set at the required distance apart.

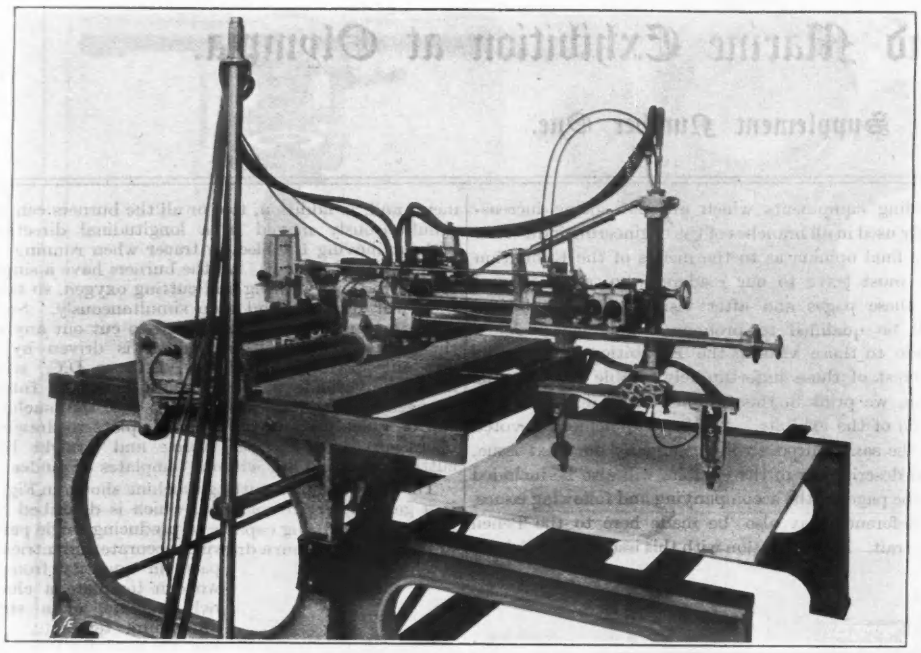


FIG. 2—UNIVERSAL OXYGEN PROFILING MACHINE—HANCOCK

GAMBRELL RADIO COMMUNICATIONS, LTD.

A rotating loop type direction finder, shown in Fig. XI of the Art Supplement, exhibited by Gambrell Radio Communications, Ltd., has been approved by the Board of Trade and the Postmaster-General for installation on ships. Owing to complete screening and the symmetrical arrangement, exceptional accuracy and very sharp signal minima are said to be obtained. As no magnetic material is used in the construction it can be used in close proximity to the ship's compass. The apparatus is equally suitable for large and small vessels, the range of reception is wide, and it meets all normal requirements.

An auto-alarm on view has also been approved by the British Post Office and the Board of Trade. It is an entirely self-contained apparatus and can be fitted in any ship regardless of its type of main wireless equipment. The absence of continuously rotating parts makes a high degree of reliability possible. The equipment consists of three main parts—a selector, a receiver, and a control unit. A 12-volt battery, two 50-volt batteries, and alarm bells in the bridge, wireless room, and operator's cabin are provided.

A marine radio-telegraphic installation exhibited has been officially approved as the main wireless installation for compulsorily fitted ships, and provides an economical means of complying with statutory requirements. It is particularly suitable for cargo vessels or short-voyage passenger or other ships on which wireless traffic needs can be satisfied by installing efficient low-power equipment. As it allows for communication on continuous-wave and interrupted continuous-wave telegraphy, at ranges of from 1000–1500 miles, it meets all normal traffic requirements. The equipment not only covers normal ship traffic requirements on 600/800 m., but provision is made for reception over the full wave range of 15 m. to 20,000 m. Telegrams sent *viâ* Rugby can therefore be received as well as time signals, weather and Press bulletins, &c., sent out by stations on wavelengths other than those usually provided for on ships' wireless receivers.

A lifeboat wireless equipment complies fully with statutory requirements. All the units are completely watertight and are built to ensure the utmost reliability under severe conditions. The tuned circuits are adjusted to the emergency wavelength of 600 m., and a control allows of fine adjustment. The working range under normal conditions to a ship fitted with low-powered equipment can be taken as not less than 65 nautical miles, but much longer distances can be covered to ships with modern and more powerful installations.

Among other exhibits is a short-wave marine radio-telegraphic installation with all the latest improvements. It may either be supplied complete as a self-contained installation or as an attachment to the main radio-telegraphic installation. In the latter case the transmitter draws the necessary power supplies from the main equipment and is controlled from the main control panel. A switch is fitted to give immediate change-over from one set to the other. The combination of the short-wave transmitter and the main installation will cover all normal traffic and long-distance short-wave working requirements of large vessels, and as the complete installation occupies no more space than that taken by many medium-wave sets, it can be fitted in small ships to give them the many advantages of direct long-range communication.

JOHN LILLEY AND SON, LTD.

The exhibits of John Lilley and Son, Ltd., of The New Quay, North Shields, are mainly confined to improvements in compasses and binnacles for navigational requirements. The high-speed engines and auxiliaries of motor vessels have made improved compass suspension systems desirable. Our engraving, Fig. VII of the Art Supplement, illustrates the "Unit" tureen-top compass. The suspension is combined with a stabilised bowl to maintain a 10in. dry card, weighing about 140 grains, in a steady condition under conditions of bad sea weather. This method of suspension is claimed to obviate the necessity for liquid compasses, in which the liquid is used for damping the oscillations of the card. The "tureen" binnacle top, as can be seen in the engraving, can be rotated on journals when the compass is required to be uncovered, the binnacle top swinging underneath the bowl. The usual type of binnacle top has to be removed and placed on the deck when an azimuth bearing is required.

On the stand is shown a small liquid yacht compass which incorporates a magnifying system, enabling the card to be seen from almost any position in a cockpit. The same magnifying system may be used for taking bearings without any additional appliances, and similar magnifying systems are applied to the standard and steering compasses used on board large vessels. This yacht compass provides a vertical magnification, which, it is stated, enables readings to be taken 6ft. to 8ft. away. The glass window can be lowered out of the way in order to eliminate reflections. It is desirable that there should be no light in the wheelhouse of a vessel, in order that a good look-out may be kept. For this purpose the compass is fitted with the "No-Glare" system of lighting, which, it is stated, prevents dazzle.

Further exhibits on the stand are instruments for taking bearings, such as the Q.E.D. Pelorus, and improved azimuth instruments. A tide computor, on the Layton principle, is shown, which facilitates the accurate computing of the times of high water by means of the harmonic constituents now provided in the Admiralty tide tables.

L. STERNE AND CO., LTD.

A wide range of ammonia and CO_2 compressors is on view on the stand taken by L. Sterne and Co., Ltd., of the Crown Ironworks, 158–160, North Woodside-road, Glasgow, N.W. In addition, as mentioned below, the associated company, the Haslam Foundry and Engineering Company, Ltd., is contributing exhibits.

A self-contained ammonia refrigerating machine is shown in the accompanying engraving, Fig. 3. This model is known as the Mark "2 T" machine, and consists of a small twin-cylinder vertical enclosed ammonia compressor directly coupled to a 5 H.P. electric motor. The compressor and motor are mounted on a cast iron bed-plate, in which is housed the ammonia condenser. These machines are widely used for cooling provision chambers on board cargo vessels and oil tankers.

Other machines shown include the Mark "3 V C" vertical enclosed two-stage ammonia compressor, directly coupled to a vertical enclosed steam engine. This type of ammonia compressor is suitable for low-temperature refrigeration, using comparatively large compression ratios. The set is supplied complete with a liquid injection type intercooler for cooling the gas between stages. The machine is fitted with a forced lubrication system, and the two-stage compressor cylinders are of the stepped type. The annular space between the large and the small ports forms the low-pressure cylinder.

Another ammonia compressor shown is the Mark "4 P" single-stage compressor, which is arranged for V-rope drive. This machine has four cylinders, $4\frac{3}{4}$in. bore and 4in. stroke, and can be run at speeds up to 750 r.p.m. It forms a unit of the company's standard range of vertical enclosed ammonia compressors for ordinary refrigerating work. It is fitted with a forced lubrication system, spring-loaded safety compressor heads, and light ring plate valves.

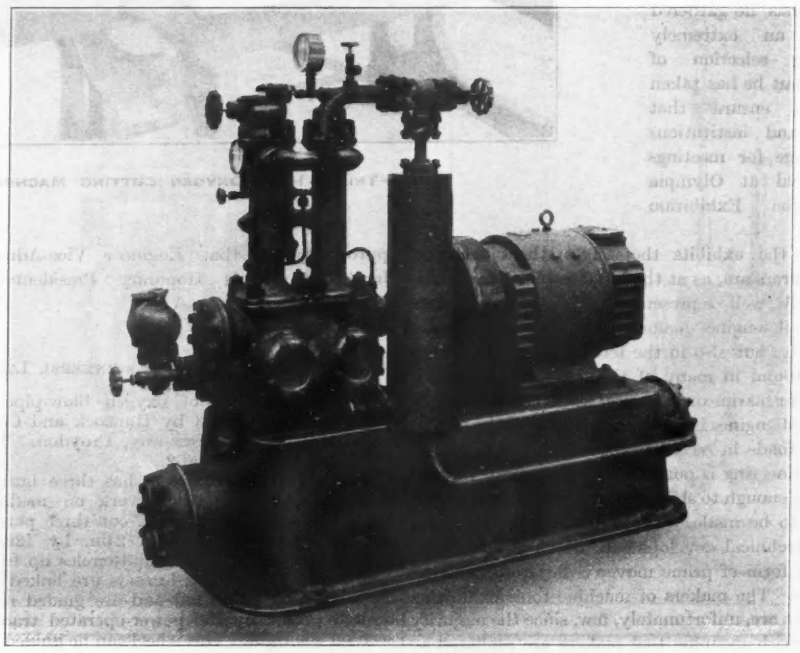


FIG. 3—AMMONIA REFRIGERATING MACHINE—STERNE

A methyl chloride refrigerating machine with a 3 H.P. motor shown is the No. 5A "Sternette," illustrated in Fig. XVII of the Art Supplement. This set comprises a three-cylinder vertical enclosed compressor, driven by means of a V-rope from an electric motor. The two units are mounted on a common cast iron bedplate, in which the shell and tube type condenser is housed. A smaller type of methyl chloride motor-driven machine is also shown, known as the No. 2A "Sternette." A 1 H.P. motor drives the small enclosed twin-cylinder compressor, again by means of a V-rope drive.

A small air-conditioning unit is exhibited in which the air is circulated by a motor-driven propeller fan mounted near the top of the unit. Galvanised finned cooling coils are so arranged that as the brine is sprayed over the coils formation of frost is eliminated at temperatures below the freezing point.

HASLAM FOUNDRY AND ENGINEERING COMPANY, LTD

Most of the exhibits of the Haslam Foundry and Engineering Company, Ltd., of the Union Foundry, City-road, Derby, are provided by the associated company, L. Sterne and Co., and are described above under that firm's heading. A Haslam vertical enclosed marine-type CO_2 compressor, illustrated by Fig. XVI of the Art Supplement, is shown, however, on the stand. This machine runs at speeds up to 400 r.p.m., and is suitable for direct coupling to an electric motor or a steam engine. Under normal conditions it absorbs up to 12 H.P. The machine is of the single-acting type, with cylinders of 2in. bore and 3½in. stroke, and is fitted with a forced lubrication system, with the motion work entirely enclosed in a cast iron crank case. The two cylinders are fitted with renewable cast iron liners, and although of the single-acting type, they are fitted with piston-rod glands with

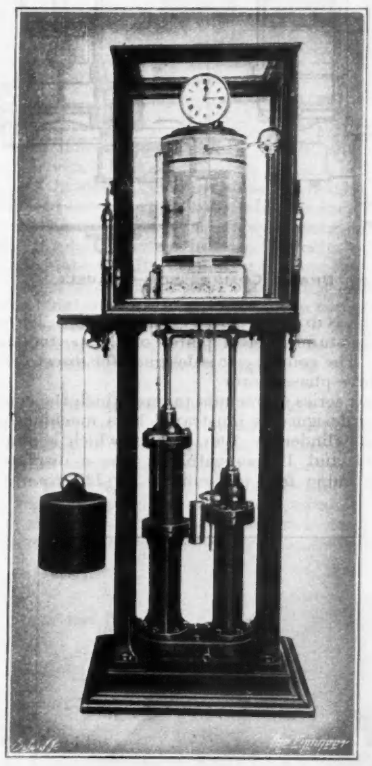


FIG. 4—VENTURI RECORDER—KENT

special metallic packing, in order to prevent the CO_2 gas from entering the crank case. The valves are of the poppet type, with dashpots, in order to give silent running. Of high-tensile forged steel, the crankshaft is balanced and is carried in three adjustable main bearings. The crossheads are of the open type with flat slippers and adjustable guide bars. The compressor cylinders can be arranged for multiple effect compression, if required.

Also shown on the stand is a small Haslam automatic float-operated liquid precooler for use with multiple effect CO_2 compressors. The steel vessel is sectioned to show the internal mechanism. This arrangement is used for the automatic regulation of the precooler on multiple effect CO_2 compression systems, whereby the liquid CO_2 is cooled to a comparatively low temperature by partial evaporation, the gas passing to the multiple effect ports on the compressor. This precooler will now, of course, supersede the hand-operated type of precooler.

GEORGE KENT, LTD.

Among the instruments exhibited on the stand taken by George Kent, Ltd., of Luton, Beds, is the Multelec recorder, an instrument capable of recording and controlling a number of conditions, such as temperature, pH or electrolytic conductivity. The engraving, Fig. 5, shows the instrument in the form of a temperature recorder. These instruments are made in single-point and multi-point form. In the single-point recorder a large capacity pen traces a continuous record, whereas in the multi-point type as many as six temperature records can be printed concurrently on the same chart, switching from one point to another every minute.

The line engraving, Fig. 6, herewith, is a diagrammatic arrangement of a single-point temperature recorder illustrating the principle of operation of the instrument. The pointer 1 of a bi-filar type of galvanometer detects any small change in the conditions being measured. A deflection of the pointer is transmitted by the setting levers 2 so as to position the arm 3. Every two seconds this arm is connected through a clutch to the disc 4, the cams 5 bringing the arm back to the

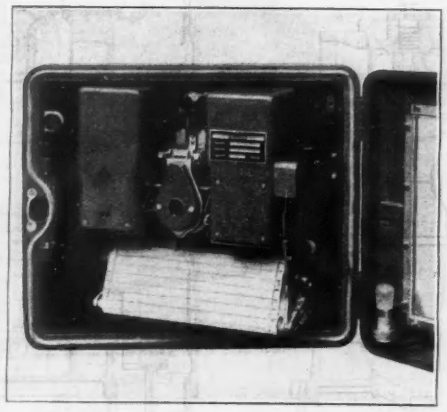


FIG. 5—"MULTELEC" TEMPERATURE RECORDER—KENT

initial horizontal position and rotating the disc, thus transmitting the galvanometer movement to the shaft 6. It is arranged that the galvanometer pointer shall be clamped at the moment when the levers move together, and thus the pointer is not subjected to strain. The transmission of the deflection of the pointer is performed by means of an external source of power, so that no duty is imposed on the galvanometer. A post on the arm 3 is adjustable, so that the ratio of the pointer movement to the rotational movement of the shaft can be varied, and thus permit optimum sensitivity to be obtained for any range. It will be seen that a variation in the applied potential, as a result of a change in the conditions being measured, will be compensated for by the movement of the slidewire disc 7 on the shaft 6. Both the slide-

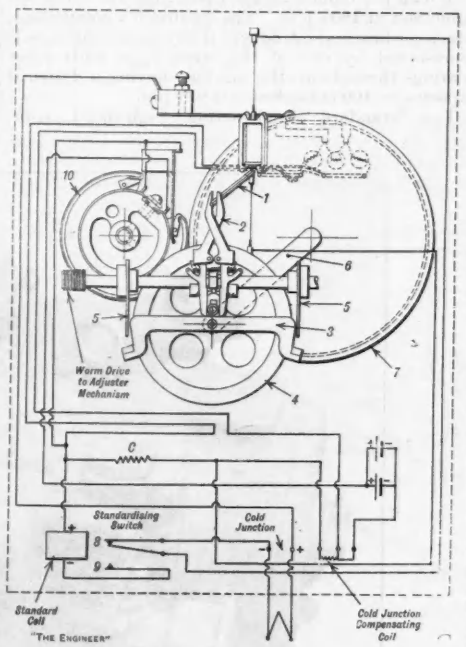


FIG. 6—MECHANISM OF TEMPERATURE RECORDER—KENT

wire disc and a cord wheel, which controls the movement of the recording device, are moved proportionately to the galvanometer deflection.

When a potentiometer type of circuit is used, as described above, the circuit current is automatically standardised by an adjusting mechanism which is made to operate at definite intervals. When the potentiometer current is to be checked, the contact 8 is broken and the contact 9 made, thus placing the standard cell across the coil C and disconnecting the measuring element. At the same time the periphery of the slidewire disc 7 is brought into contact with the edge of the battery rheostat 10, which is thereby rotated by the measuring mechanism until the correct current value is restored.

In a multiple-point recorder a selector switch, capable of being adjusted for contact pressure, is interposed between the contacts of the current adjuster switch, 8 and 9, and the primary elements. In this case the current standardisation occurs synchronously with the changing from point to point, so that the balancing and recording of each point is unaffected.

The "Multelec" can be used for the measurement or control of the pH value of industrial solutions. The pH value denotes the effective acidity or alkalinity of a solution, and is determined by measuring the concentration of the hydrogen-ions or hydroxyl-ions which it contains. In this case the recorder circuit becomes a special potentiometer, with automatic temperature compensation by means of resistance thermometers. A choice of primary elements is available, including the antimony-calomel type.

A shunt meter, for steam and air, is shown in Fig. VIII of the Art Supplement. This type of instrument is suitable for measuring steam or air in small mains and need only be fitted between flanges on the main. A portion of the flow passing in the main is diverted by an orifice plate through the nozzles of a small turbine, arranged in a shunt circuit. The speed of the turbine is kept low by means of a damping fan rotating in water, which thereby reduces the wear on the mechanism and at the same time, it is claimed, increases the range of the meter, since it increases the relative velocity between the impinging fluid and the turbine.

Other instruments on the stand include many that are familiar to readers of THE ENGINEER, and need no description, such as the K M steam meters, ring balance recorders, and Venturi recorders. An integrating and recording instrument of the Venturi type is shown in Fig. 4.

MEK-ELEK ENGINEERING COMPANY.

For local illumination on drawing boards, machine tools, sewing machines, inspection benches, &c., the Mek-Elek Engineering Company, Ltd., of 16, Douglas-street, Westminster, S.W.1, is exhibiting special lighting fittings, as shown in Fig. 7. It is often necessary that light of high intensity should be directed at an angle to avoid shadows from parts of a machine or from the worker himself, and these adjustable lighting units meet this requirement. As the reflector concentrates the light where it is required, a small lamp can be employed with consequent economy, and by enabling operators to work in comfort, production is facilitated. Faulty work is also less liable to be produced. The epicyclic geared joints with which the fittings are provided give a wide range of adjustment and provide means of taking cab-tire

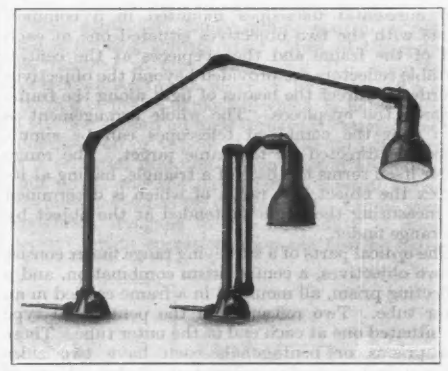


FIG. 7—LIGHTING FITTINGS—MEK-ELEK

cable through the fitting without cable loops, which are liable to be kinked and nipped when the arms are moved. There is no alteration in length of cable throughout the movement, and consequently no pull on the terminals. A swivelling head carries the reflector and protects the lampholder from damage. Various types of bases are supplied for cab-tire or conduit wiring. The units are claimed to withstand rough handling in workshops, and they comply in all respects with the Home Office regulations. The exhibits include floor, bench, wall, and ceiling mounted units, portable units, and others for fixing directly to machines, including a special unit with a suds-proof housing to enclose the lampholder when used on a machine tool.

The fittings can be supplied for ordinary voltages or with a transformer for stepping down to 12 volts, which enables a lamp with a robust filament to be employed and also eliminates the risk of shock.

BARR AND STROUD, LTD.

Barr and Stroud, Ltd., of 15, Victoria-street, London, S.W.1, are exhibiting navigational range finders, surveying range finders and prismatic binoculars. By the use of a range finder the navigator is enabled to measure directly his distance from any object in sight by day or from a light at night by means of a single observation, without the necessity for calculation or reference to tables.

It is claimed that the one-man range finder equipment for rapidly measuring distances in land survey-

ing can give ranges up to 20,000 yards with a degree of accuracy well within that required in preliminary survey work from one point of observation. Thus the work usually involved in surveying new tracts of country can be reduced to a great extent by the use of this instrument, which is exhibited on the stand. One essential feature of such an instrument is its portability. It is said that each of the sizes of instrument shown can be carried easily by one man from one station of observation to another and that the taking of ranges is also a one-man job.

The range finder may be regarded as consisting of two horizontal telescopes mounted in a common frame with the two objectives situated one at each end of the frame and the eyepieces at the centre. Suitable reflectors are provided beyond the objectives in order to direct the beams of light along the frame towards the eyepieces. The whole arrangement is such that the combined telescopes can be simultaneously directed on the same target. The range finder itself forms the base of a triangle, having at its vertex the object, the range of which is determined by measuring the angle subtended at the object by the range finder.

The optical parts of a surveying range finder consist of two objectives, a centre prism combination, and a deflecting prism, all mounted in a frame carried in an outer tube. Two reflectors of the pentagonal type are situated one at each end of the outer tube. These end prisms or pentagonals each have two sides silvered and mutually inclined at 45 deg. Rays of light from any direction, provided they are in the same plane as the section of the prism, enter through one of the non-silvered faces and are reflected by both silvered faces so as to emerge through the other non-silvered face at right angles to their line of entry.

The face piece situated at the centre of the outer tube carries the left and right eyepieces. The field of view, as seen through the right eyepiece, is divided by a fine horizontal line called the separating line, so that there are two fields of view, the upper and the lower. When the range finder is trained on an object an image of it is seen in each field. In the case of surveying range finders the upper image is inverted, in order to enable ranges to be taken more easily in country where the observer is dependent on such objects as boulders, trees, and other irregular shaped objects.

By moving the deflecting prism, which is effected by rotating the "working head" situated on the outer tube convenient to the observer's right hand, the two images can be brought into coincidence. The range finder scale moves with the deflecting prism and when coincidence is made the range is read directly from the scale seen in the left eyepiece. The scale may be graduated in yards, metres, cables, or any other desired unit.

It will be seen that the accuracy of any range finder depending on triangulation—as the Barr and Stroud instruments do—is directly proportional to two things, namely, the base length and the magnification. The 1 m. and the 80 cm. base range finders have the same magnification of 14, but owing to the increase of base length the 1 m. base range finder has an accuracy 25 per cent. greater than the 80 cm. range finder.

The engraving, Fig. VI of the Art Supplement, shows the navigational type of instrument. This range finder has a base of 4ft. 6in. and is on a pedestal mounting provided with a Pelorus ring. It is suitable for liners, large passenger and cargo ships, and cable laying and repair ships.

REAVELL AND CO., LTD.

On the stand of Reavell and Co., of Ranelagh Works, Ipswich, is shown a very complete collection of the firm's standard products, including two double-acting, two-stage, intercooled compressors for 100 lb. pressure, one of which is to deliver 1000 cubic feet of air per minute at 360 r.p.m., and the other 500 cubic feet at 480 r.p.m. The quadruplex compressor, which the firm first introduced thirty-eight years ago, is represented by one of the latest type with roller bearings throughout, the machine having a designed capacity of 400 cubic feet at 580 r.p.m.

Two standard single-acting high-speed compressors are shown, and two of the single-acting, two-stage type; also one rolling drum rotary compressor, and one of the smallest sizes of compressor without the rolling drum. One of the standard rotary air engines arranged to act as an air starter for high-speed oil engines is also exhibited.

Enlarged photographs of machines in all standard sizes in independent groups are shown, and these serve excellently to illustrate the great range of sizes in which these reciprocating and rotary compressors are made.

The new exhibits shown for the first time include a two-stage intercooled compressor of 400 cubic feet capacity at 580 r.p.m. This interesting compressor is of the single-acting type with automatic lubrication, and is shown in section in the drawing, Fig. 8. As will be inferred from Fig. 8 and Fig. XIX of the Art Supplement, the machine is of the three-crank type with two low-pressure cylinders, each delivering air into the two-pass cooler, and thence to the high-pressure cylinder, the piston of which is driven from the central crank. The valves are thin stainless steel plates of the ported annular type. The compressor is designed for direct coupling to a three-phase motor.

A new series of vacuum pumps which the company has just designed is illustrated by a machine having a 12in. cylinder by 10in. stroke, which is shown in Figs. 11 and 12 herewith. It has a displacement of 295 cubic feet per minute at 225 r.p.m. The machines are designed to give a vacuum to within ¼in. or ½in. of the barometer, depending on the working conditions, and are made in sizes from 160 cubic feet up to 2000 cubic feet per minute displacement. They are fitted with ported annular thin-plate valves, the inlet valves being arranged at the top and the delivery valve at the bottom, so as to give effective drainage if any moisture should be entrained with the air to be evacuated.

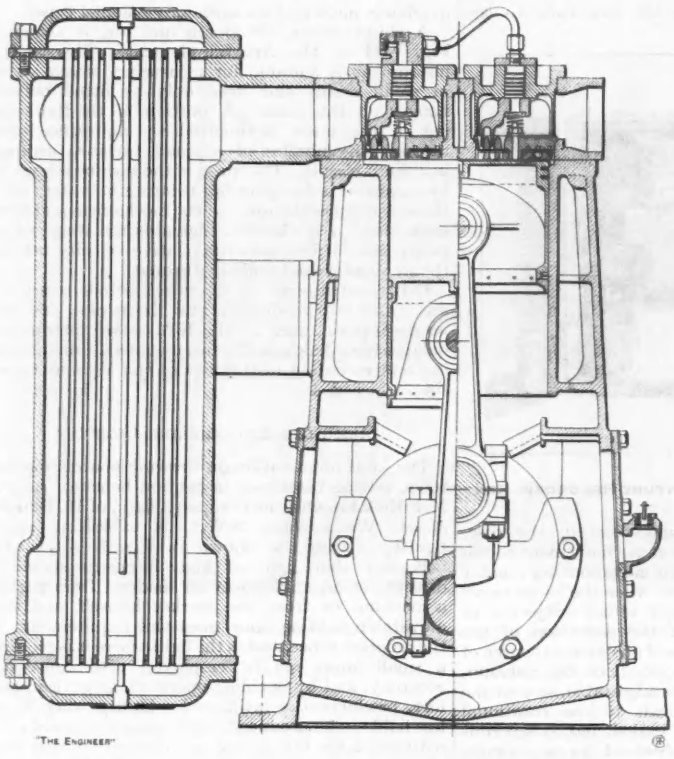


FIG. 8—TWO-STAGE INTERCOOLER AIR COMPRESSOR—REAVELL

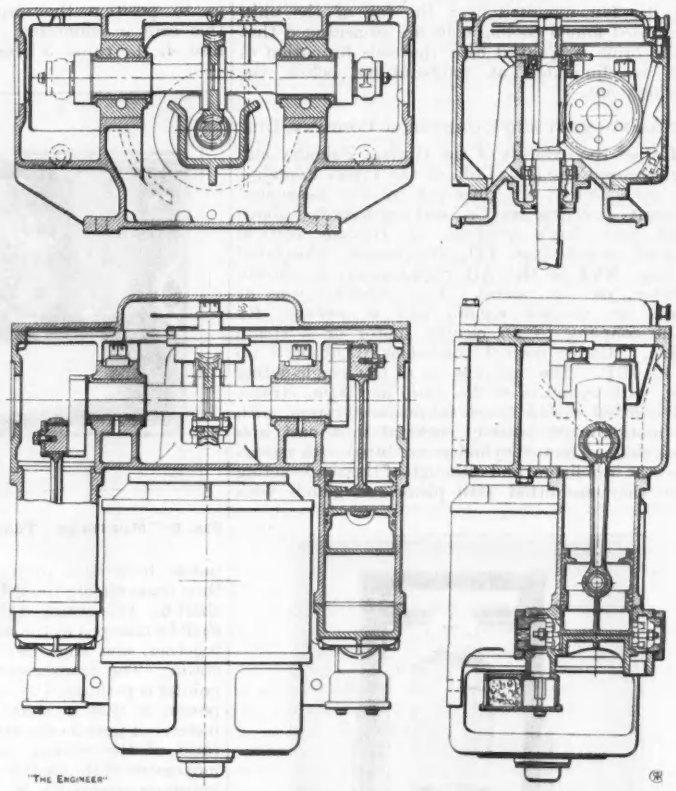


FIG. 9—ARRANGEMENT OF BRAKE COMPRESSOR—REAVELL

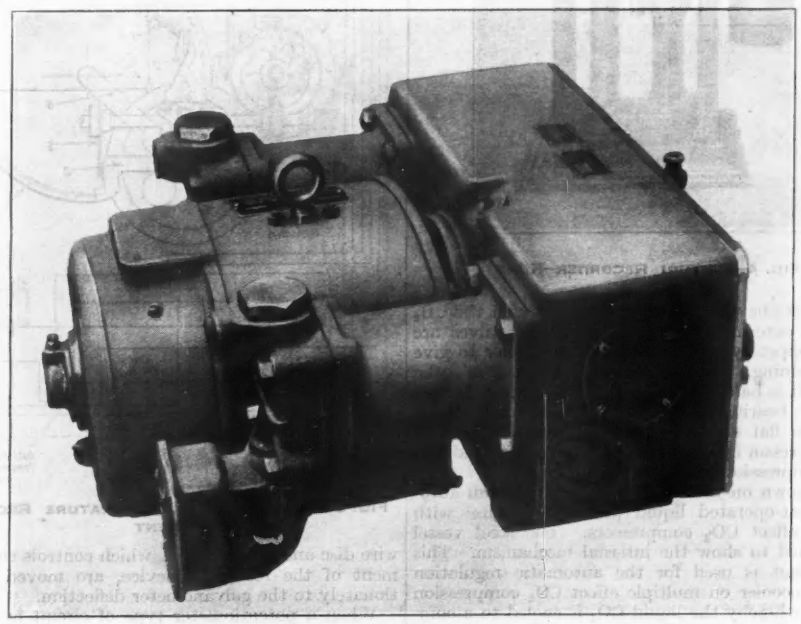


FIG. 10—WORM-DRIVEN BRAKE COMPRESSOR—REAVELL

These pumps are arranged for belt driving from electric motors, either by means of flat or "V" belts. A mechanical lubricator is supplied to give an accurate rate of feed to the main bearing, connecting-rod bottom end, crosshead, and cylinder. As the example exhibited shows, the pumps are all arranged for water jacketing.

In connection with the operation of brakes on tramcars, &c., two new types of compressors are shown.

Reavell and Co., Ltd., has supplied for brake equipments in connection with G. D. Peters and Co., Ltd., of Slough, large numbers of high-speed, two-

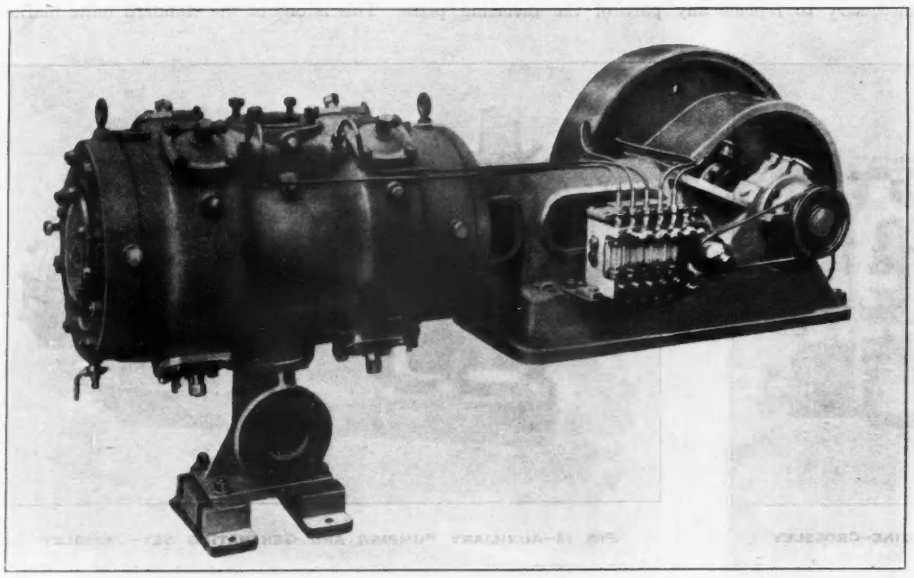


FIG. 11—STRAIGHT LINE VACUUM PUMP—REAVELL

crank, balanced compressors, which are directly motor driven.

One of these compressors is an air-cooled, high-speed machine of the two-stage type, which is very compact and is designed to ensure a supply of reasonably cool air for the brakes when fitted on vehicles operating in hot countries. By dividing the compression into two stages this design also avoids any difficulties in hot climates which might arise from carbonisation of oil, because the first stage delivery is at about 30 lb. pressure, and the delivered air is cooled by a gilled intercooler before it passes to the second stage.

The second compressor for brakes embodies a particularly neat construction and runs very silently, and is shown in Figs. 9 and 10. It has been introduced for cases where slow-speed running is preferred. While of necessity such a machine is heavier than the high-speed type, the adoption of a high-speed motor placed between the two compressing cylinders and a worm and worm wheel drive makes a very compact and flat type of machine, while the use of the worm and worm wheel ensures a silent speed reduction. Lubrication is effected by a light disc attached to the end of the high-speed worm shaft which throws an adequate supply of lubricant over the bearings of the machine, and effectively lubricates the worm and worm wheel drive.

Another new development exhibited on the stand is that of a high-pressure charging set for supplying air at 350 lb. per square inch for starting oil engines. It consists of a twin construction in which the petrol engine piston is opposed by the compressor piston, and by the adoption of the two-crank design with the cranks opposed a very neat and well-balanced machine is produced. The speed of this unit is 1250 r.p.m.

A complete working exhibit of a Reavell-Askania regulator is also to be seen on the stand. It is arranged as a constant-volume regulator, and air is supplied by a motor-driven fan and is delivered through a 2in. bore pipe. The air quantity is measured by a small orifice plate, which at full volume sets up a differential pressure of 2in. W.G., and the regulator operates a control valve arranged at the end of this pipe. The differential pressure set up by the orifice plate, which is, of course, a measure of the volume, is shown on a Cambridge Instrument Company's volume-indicating gauge. A hand-operated valve is provided so that the conditions may be altered and the operation of the regulator, which promptly restores the volume to the set value, is thus demonstrated.

In addition, a complete exhibit of a Reavell-Askania regulator is shown, which exhibit is sectionalised so that the internal construction of this very ingenious method of obtaining accurate control can be readily seen.

W. AND T. AVERY, LTD.

Machines for carrying out all the usual physical tests upon metallic specimens are shown on the stand of W. and T. Avery, Ltd., Soho Foundry, Birmingham. Prominent among them is a self-indicating Universal testing machine of 50 tons capacity, suitable for carrying out the standard tests in tension, compression, bending, shearing, and hardness. The load is indicated on a graduated dial in clear view of the one operator required. The machine is particularly suitable for quick commercial requirements, but as the speed is readily controllable the rate of straining can be extremely slow if so desired.

Two hardness testing machines are shown. One, of the self-indicating type, has been specially designed for rapidly determining the Rockwell hardness of materials in terms of standard penetration. A direct numerical reading is given on the dial, necessitating no subsequent measurement or calculation. The method of testing is such that all errors due to surface imperfections of the specimen are eliminated, and the whole operation, which is extremely simple, can be carried out in approximately 10 seconds. The machine is therefore mainly suitable for production testing, and since the mark left by the penetrator is so slight, many finished articles can be tested without damage.

The other machine is designed to carry out the standard Brinell hardness test. It is constructed to the high degree of accuracy and with the finish of a scientific weighing machine, and being calibrated by means of deadweights, an accuracy of one-thirtieth of 1 per cent. can be guaranteed. Special features of this machine are that the load is gradually applied through a worm drive, and that it can be maintained for any prescribed time period.

The determination of fatigue stress in metals is catered for by the fatigue testing machine shown in Fig. IX of the Art Supplement, which is designed for applying alternating bending stresses upon metals. It is arranged to test the cantilever form of specimen by single point loading as originated by Wöhler. The shock stress resistance of materials can be determined by the Avery Izod impact testing machine, in which the quadrant is inverted to facilitate reading and other important refinements have been effected. Another interesting machine is an electrically operated spring scragger, which is suitable for carrying out tests upon either coil or laminated springs. The machine is very flexible, so that small and delicate springs can be scragged with the same control as those requiring full capacity.

The problem of wear, hitherto approached indirectly by the measurement of friction, can now be dealt with in a more direct manner by means of the Avery-Brownsdon wear and lubricant tester. The method of operation consists of bringing a flat stationary sample of one metal into frictional contact with the periphery of a rotating wheel of another metal under known conditions of speed and dimensions of the wheel, load, temperature, lubrication, and duration of the test. The impression so made in the flat sample of metal is then taken as a measurement of wear much in the same way as the impression of a ball or cone penetrator is taken as a measurement of hardness.

RADIOVISOR PARENT, LTD.

The exhibits of this company comprise light-actuated apparatus, including a smoke indicator and alarm, a counting unit, a turbidity indicator, a bar heater controller, flame failure control apparatus, and a lighting control unit. Most of these devices are familiar to our readers, but the flame failure control apparatus is more or less new. To avoid the risk of fire or explosion which is liable to occur if the flame of an oil-fired furnace is extinguished and unignited oil or vapour is injected into the furnace, it is essential that the burner should be completely shut down, and the flame failure control apparatus has been developed for this purpose. Unlike previous apparatus designed for the same duty, it does not depend for its operation upon the heating action of the flame, but upon the light rays emitted when the combustion of the oil occurs. The rays impinge upon the light-sensitive cell housed in a focusing tube through which a stream of cold air is continuously passing, thus ensuring that any carbon that may be blown back from the combustion chamber is kept clear of the glass envelope of the cell. The time of operation of the apparatus, which is known as the "Lumastat," is normally between two and three seconds, but, if necessary, it is possible for the

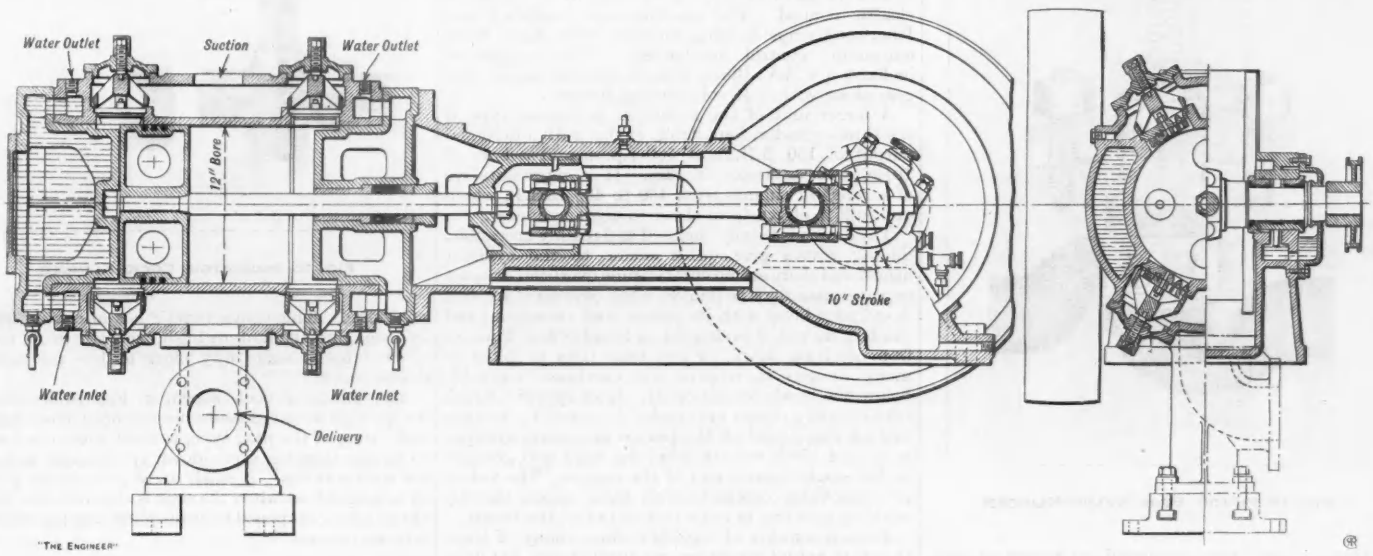


FIG. 12—LONGITUDINAL AND CROSS-SECTIONS THROUGH VACUUM PUMP—REAVELL

apparatus to work practically instantaneously. Failure of the flame may be due to ignition failure, oil failure, or air, and in each case the "Lumastat" will interrupt a supply of electrical energy in a control circuit until such time as the correct working conditions have been renewed, when by merely pressing a button the burner will begin to operate again. If desired a light or bell may be employed to give warning when the burner has shut down. The apparatus is shown in Fig. X of the Art Supplement, where the focusing tube for the light-sensitive cell is to be seen on the right and the control box on the left.

CROSSLEY BROTHERS, LTD.

The group of oil engines displayed by Crossley Brothers, Ltd., of Bush House, London, and Openshaw, Manchester, is one of the largest in the Olympia Exhibition. It includes nine engines specially designed for marine propulsion, auxiliary work, and industrial drives, with outputs from 6 to 330 B.H.P. The engines include practically all the types manufactured by the firm, with the exception of the large Crossley-Premier engines used for mining, industrial and marine service.

In Fig. I of the Art Supplement we illustrate the largest engine shown on the stand, which is a six-cylinder, two-stroke scavenge pump engine with a designed output of 330 B.H.P. at 330 r.p.m., built for direct reversing, heavy duty marine propulsion service. The cylinders have a bore of 10½in. with a stroke of 13½in. A special feature is the direct reversing by means of compressed air supplied from the starting bottles, which are kept fully charged by means of an engine-driven air compressor. The starting and manœuvring controls are neatly grouped at the end of the engine, and can be arranged for either direct or remote control. There is a single control wheel for manœuvring, which operates in connection with a pointer moving over a scale.

When the compressed air has been turned on the hand wheel is rotated till the "start" position on the indicator plate is reached, when the engine starts up from cold on air. On moving the hand wheel further into the "run" position, the engine runs on fuel oil. Reversing is effected with equal simplicity. The whole operation of starting, running; and stopping, is a matter of a few seconds only, and the claim of the builders that the engine starts and runs with one revolution of the crankshaft will be demonstrated during the Exhibition. In the large engine illustrated the controls are direct, but an engine of similar design—a four-cylinder unit with a designed output of 100 B.H.P. at 450 r.p.m., and with a bore of 7in. and a stroke of 9in.—is shown fitted with remote control.

A special feature of these engines is the very simple form of reverse gear, which, we are informed, has proved so satisfactory in practice that it has been unnecessary to replace any part of the reversing mechanism either by wear or any other cause since the engines were first introduced in 1933. There is no clutch needed with the direct reversing engine, and as high torque is developed at slow speeds these engines are particularly useful in harbour and towing service. As an indication of the slow-running qualities it may be stated that the large 300 r.p.m. engine will idle at 80 r.p.m., while the 100 B.H.P., 450 r.p.m. engine will run at 100 r.p.m.

Another interesting exhibit is the four-cylinder, four-cycle engine illustrated in Fig. 13, which has a designed output of 56 B.H.P. at 1000 r.p.m., with a bore of 5in. and a stroke of 6½in. It is complete with reverse and reduction gearing, and has been particularly designed to meet the demands for a light engine occupying small space and running at a high speed. In the design and construction of these engines free use has been made of high-grade alloy steels. The fuel pump is of the port-controlled pattern, and its only valve is the non-return delivery valve. The engine is arranged for air starting, but hand starting can also be provided. It will be noted that engine-driven bilge and circulating pumps are embodied in the design.

A similar engine is of the six-cylinder type, driving a 55-kW, 220-volt D.C. generator, with automatic electric control. The dynamo is a Campbell and Isherwood single-bearing machine with Allen West automatic control mechanism. The equipment includes a C.A.V.-Bosch Bendix starting motor and gear along with a 24-volt starting battery.

A larger unit of the industrial or marine type is the three-cylinder, four-stroke engine with a designed output of 150 B.H.P. at 500 r.p.m. and a bore of 10½in. with a stroke of 12in. It is representative of a range of engines from 150 to 400 B.H.P. which are built to have from three to eight cylinders.

The design is totally enclosed and readily accessible. Sliding covers give quick access to the cylinder heads, and there are no cumbersome overhead exhaust or water manifolds to remove when overhauls are due. A cylinder head with its piston and connecting-rod can be removed, it is claimed, in twenty-three minutes from shutting down, or less time than is taken in many designs to remove the overhead manifolds before the heads can be got at. Each sprayer, which is of Crossley design and make, is served by its own fuel oil pump, and all the pumps are neatly grouped in a steel block cut out from the solid and grouped at the single control end of the engine. The valves are removable complete with their cages, thereby enabling grinding in to be carried out at the bench.

From a number of auxiliary units, many of them shown in actual operation, we have chosen for illustration two typical examples. Fig. 14 shows a marine auxiliary set comprising an engine, a generator, and a service pump. The engine is of the vertical four-stroke, single-cylinder pattern, with a designed output of 10 B.H.P. at 1500 r.p.m. The design includes roller bearings on the crankshaft, and ball bearings on the cam shaft. Forced lubrication is fitted throughout, and other points in the design are the use of a floating gudgeon pin, a high-tensile steel crankshaft, and a detachable cylinder liner. The generator is of the Campbell and Isherwood 110-volt type, and the drive is taken through a clutch to a general service pump of the Pulsometer self-priming centrifugal type. The designed output is 100 to 120 gallons per minute against a 100ft. head. The set is mounted on a fabricated steel base plate.

The set shown in Fig. XIV of the Art Supplement is a marine auxiliary air compressor set driven by a single-cylinder Crossley engine of a type similar to that described above, but with a designed output of 6 B.H.P. at 1000 r.p.m. Direct coupled to the engine is a Reavell two-stage air compressor with designed capacity of 7¾ cubic feet of air per minute at 350 lb. per square inch working pressure. The engine is equipped with its own water-circulating pump and strainer, and the whole unit is mounted on a fabricated steel base plate. This is one of the standard units marketed by Crossley Brothers, Ltd., for supplying compressed air for a larger propelling engine.

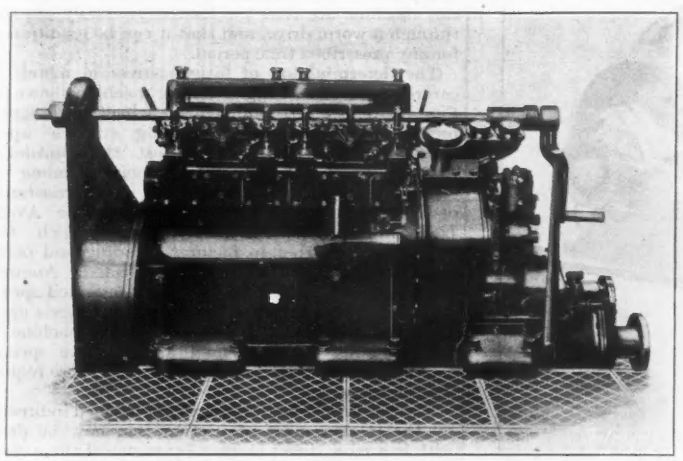


FIG. 13—FOUR-CYLINDER 56 B.H.P. MARINE ENGINE—CROSSLEY

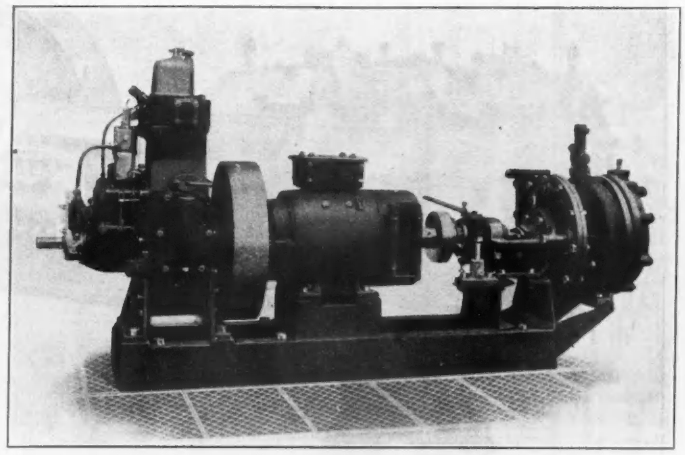


FIG. 14—AUXILIARY PUMPING AND GENERATING SET—CROSSLEY

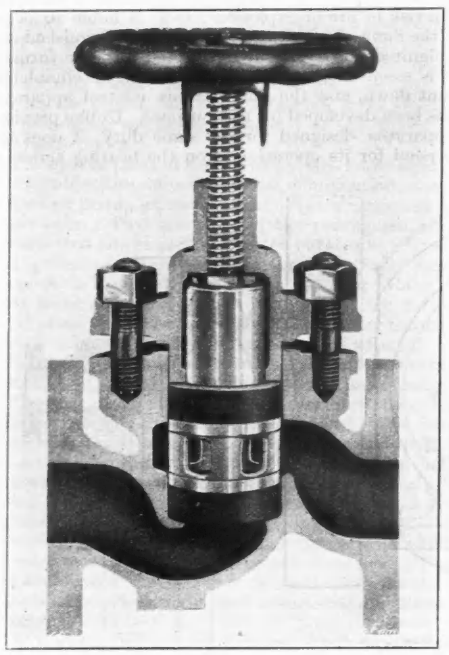


FIG. 15—PISTON STOP VALVE—KLINGER

RICHARD KLINGER, LTD.

On the stand taken by Richard Klinger, Ltd., Sidcup, Kent, there is a range of jointing materials, for which the company is well known. The fittings which we illustrate in Figs. 15 and 16 may not perhaps be so well known.

The piston or sleeve stop valve shown in Fig. 15 is a new design of a type which has been in use for the past fifteen years, and is characterised by the fact that the body is now so formed that the wall thickness of metal is practically uniform throughout. This naturally tends towards sounder castings, while at the same time a more free flow through the valve has been obtained, so that the pressure drop has been minimised. This characteristic has also been helped by arranging the lantern bush excentric in its recess, so that the passage way more or less resembles a double volute.

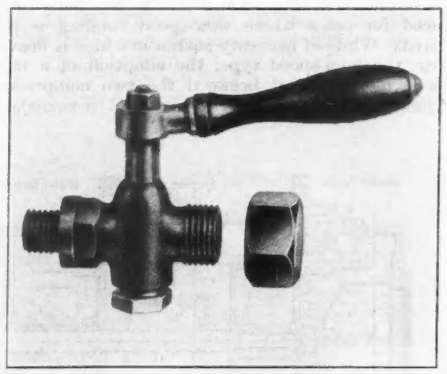


FIG. 16—INDICATOR COCK—KLINGER

The indicator cock shown in Fig. 16 is intended for the high initial pressures experienced in oil engines, and, being of the plug type, is much more convenient to handle than the screw-down type usually installed for such services. A small extra port in the plug is so arranged that when the cock is closed to the engine the indicator is opened to atmosphere and immediately returns to zero.

J. AND E. HALL, LTD.

The principal feature of the exhibits on the stand taken by J. and E. Hall, Ltd., of Dartford Ironworks, Kent, is a large marine CO_2 refrigerating machine of the horizontal twin compressor quick revolution type, with enclosed motion work. This machine is exhibited complete, with its direct-coupled motor and control pillar. It is similar to others of the same type which have been exhibited previously at this Exhibition, but embodies an interesting modification which makes it more compact than its predecessors, and is of particular value when required for installation in

'tween deck spaces. We hope to make further mention of this machine in another issue.

In addition, on the stand are shown ammonia compressors of the medium-speed "Monobloc" type. These machines are all twin-cylinder models with the two cylinders cast in one piece, as the name implies. Drive by multiple V belts is usual for compressors of this type, but they are also suitable for coupling directly to an electric motor or a steam engine. The engraving, Fig. 17, herewith, shows one of these sets driven by a steam engine. These machines are generally used with ammonia as a refrigerant, but with slight modifications methyl chloride and "Freon" can be employed.

"Hallmark" automatic methyl chloride compressors are made in a range from a twin-cylinder machine driven by a ⅓ H.P. motor up to the latest four-cylinder 4 H.P. model, which is illustrated in Fig. XX of the Art Supplement. These machines, as is usual with small automatic refrigerating compressors, are supplied with condensers of both air-cooled and water-cooled types, the last-named being specially suitable for marine purposes. The compressor shown has four cylinders with a bore and stroke of 2½in., and is fitted with a spring safety head. The valves are of the silent-working ring type. The balanced crankshaft is carried in ball bearings and the connecting-rods are of H section with white metal bearings. An automatic system provides lubricant to all the working parts. The drive to the compressor is taken by a triple V belt from the motor and the tension of the belts is adjustable. In this case the condenser is of the water-cooled type, with coils of solid-drawn copper tube in a cylindrical copper casing.

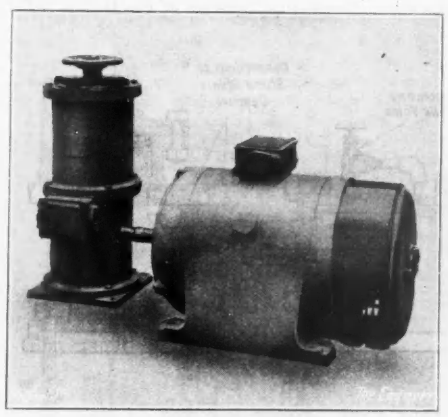


FIG. 19—MOTOR AND REGULATOR UNIT—B.T.H.

The operation of the machine is controlled thermo-electrically by the temperature of the chambers, and a high-pressure cut-out is provided as a safety device. An automatic regulator controls the gas supply to the cooling unit. The machines can also be supplied for hand control. Valves are provided for isolating completely all parts of the apparatus, and large strainers are fitted in the liquid line and in the suction valve fitting.

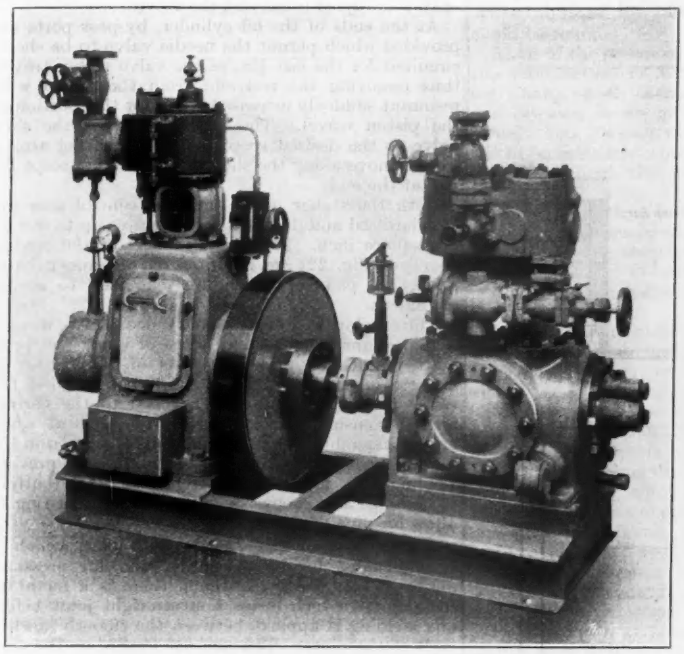


FIG. 17—STEAM-DRIVEN "MONOBLOC" COMPRESSOR—HALL

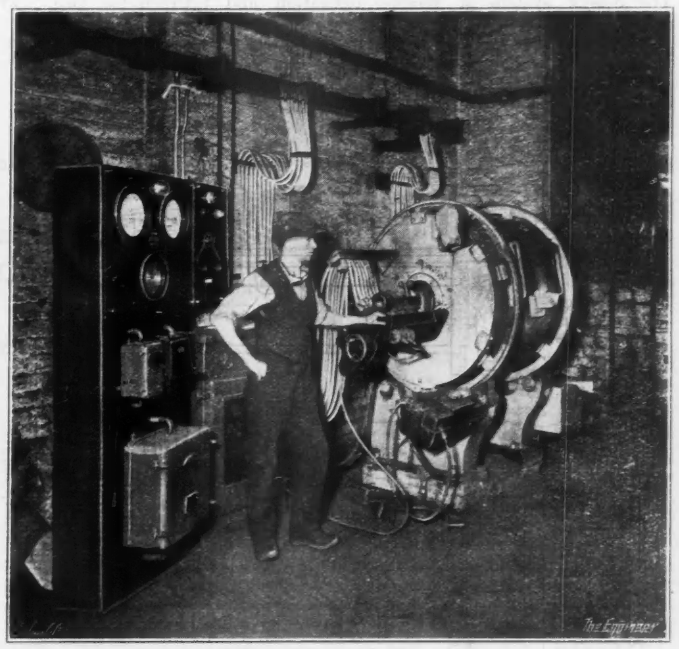


FIG. 18—"BIRLEC" DETROIT FURNACE—BIRMINGHAM

BIRMINGHAM ELECTRIC FURNACES, LTD.

Tool-room and melting furnaces are shown by Birmingham Electric Furnaces, Ltd. The "Certain Curtain" controlled atmosphere furnaces for hardening high-speed and alloy steel and alloy steel tools are shown in their latest forms. "Birlec" high-velocity air circulation furnaces, as employed for tempering and other low-temperature heat treatment operations, are represented by a model of convenient size for tool-room use. A charge progress recorder, which enables heating and soaking times to be measured accurately is exhibited. A new "Birlec" Detroit furnace (Fig. 18) is also shown. It is for ferrous and non-ferrous metals, and incorporates several improvements, including a new design of shell and patented automatic rocking control device, which is claimed to give exceptional flexibility and range of control, permitting the most satisfactory metallurgical conditions to be obtained and repeated for every type of charge.

THE BRITISH THOMSON-HOUSTON COMPANY.

Electrical equipment for use on board ships, in shipyards, engineering works, and for land service generally is exhibited by the British Thomson-Houston Company, of Rugby. The 10-kW turbo generator set, Fig. XXII of the Art Supplement, consists of a high-speed turbine with a single helical double-reduction gear-box, driving a D.C. generator. Fitted with a direct-acting speed governor and throttle valve, independent overspeed trip governor, and shut-off valve, the set is light and compact. It is self-lubricated at all points and visual indication of the oil level in the sump is given by an oil gauge. Normally the set exhausts to atmosphere or against a back pressure.

An alternator is shown coupled to an A.E.C. oil engine. Rated at 60 kW at 0·8 power factor, 1500 r.p.m., 50 cycles, three-phase, it is suitable for driving tugs, pilot cutters, and auxiliaries.

A combined electrical set, comprising a small variable-speed motor, with regulator (Fig. 19), helical gear unit and slip-ring motor, is designed to show:—(1) The stable speed characteristics of the B.T.H. variable speed motor under varying load conditions and the simplicity of operation; (2) the construction and operation of a B.T.H. helical gear unit; (3) the application of B.T.H. spring pattern flexible couplings; (4) the design of standard slip-ring motors; and (5) the construction and operation of small B.T.H. contactor starters. The variable speed commutator motor is coupled through the double-reduction gear-box with a ratio of 3 to 1 to the slip-ring motor, which acts as a positive and negative load machine. The speed of the commutator motor is varied by the separate regulator with a hand wheel conveniently situated. The slip-ring motor has loading resistances in the rotor circuit and a reversing contactor stator switch, by means of which a breaking or overhauling load can be transmitted to the variable-speed machine. With this arrangement it is easy to demonstrate that the speed of the commutator motor remains almost constant, with a widely varying load, and that the objectional "run away" characteristic inherent in many other forms of variable-speed drive is absent.

Another exhibit shown in operation is a B.T.H. "no-lag" motor, which is too well known to need description. It is worthy of mention, however, that the motor is operated in conjunction with a thrustor actuated brake and photo-electric relay. Fitted with a brake drum and controlled by a hand-operated starter, the motor runs light. Across the front of the machine a beam of light, which normally falls on the cell of the photo-electric relay, is projected. If anyone passes so near the machine that there is a risk of his being caught in the rotating parts, the beam of light is interrupted and the relay trips the starter, when the motor is smoothly but quickly brought to rest by the thrustor applying the brake.

Fractional-horse-power motors, including split-phase, capacitor, and D.C. motors, are shown. There are also several types of A.C. and D.C. machines for marine and industrial service.

Perhaps the most original exhibit is the thyratron voltage control panel shown in Fig. 20. The advantages claimed for this type of regulator over the vibrating and rheostatic types are that moving parts are eliminated and a closer degree of voltage regulation is attained with rapidity of response and freedom from hunting. Since under steady conditions the generator field current is constant, the thyratron regulator operates more as a high-speed rheostatic regulator than as a vibrating regulator. While excitation can be supplied to A.C. or D.C. generators, since the regulator is fundamentally a controlled rectifier, a source of A.C. power must always be available. The essential elements of the regulator are:—(1) A bridge circuit with linear and non-linear resistances in a near state of balance when the voltage is

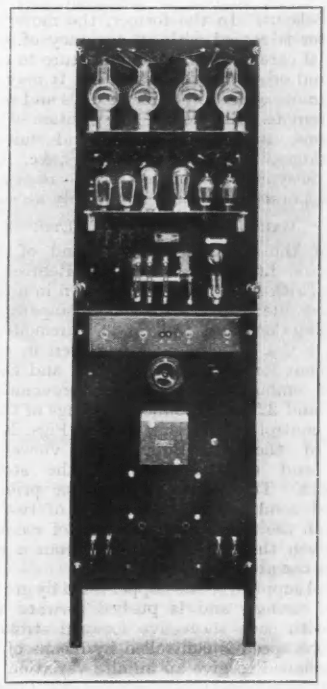


FIG. 20—THYRATRON VOLTAGE CONTROL PANEL—B.T.H.

at its proper value; (2) a thermionic amplifier circuit, which amplifies the output potential delivered by the bridge if the generator voltage deviates a fraction of 1 per cent. from the desired value; and (3) a thyratron rectifier controlled by the foregoing apparatus for the supply of current to the generator or exciter field. Although up to the present, thyratron regulators have only been made to supply field currents up to 12 amperes at 250 volts, there is no inherent reason why this rating should not be greatly exceeded. It is claimed that this type of regulator will give a closer degree of regulation than other kinds of regulator. Thyratron control applied to testing machines is said to give regulation as close as $\pm 0 \cdot 1$ per cent.

The Selsyn system of remote indication and torque transmission is demonstrated by a B.T.H. Selsyn transmitter operating in conjunction with a Selsyn receiver. The transmitter is rotated by hand, and the receiver faithfully copies the movement at a remote point. The only connection between the two units is three conducting wires. There are two types of equipments, known as precision and general-purpose Selsyns. In the former, the motion of the transmitter is copied with an accuracy of ± 1 deg., and special care is taken in manufacture to minimise friction and other disturbing forces. It may be used for the remote operation of meter dials and recorders, and the remote indication of the position of moving mechanisms, such as lifts, lock and sluice gates, swing bridges, and furnace dampers, &c. General-purpose Selsyns are employed for the remote operation of apparatus in places not readily accessible.

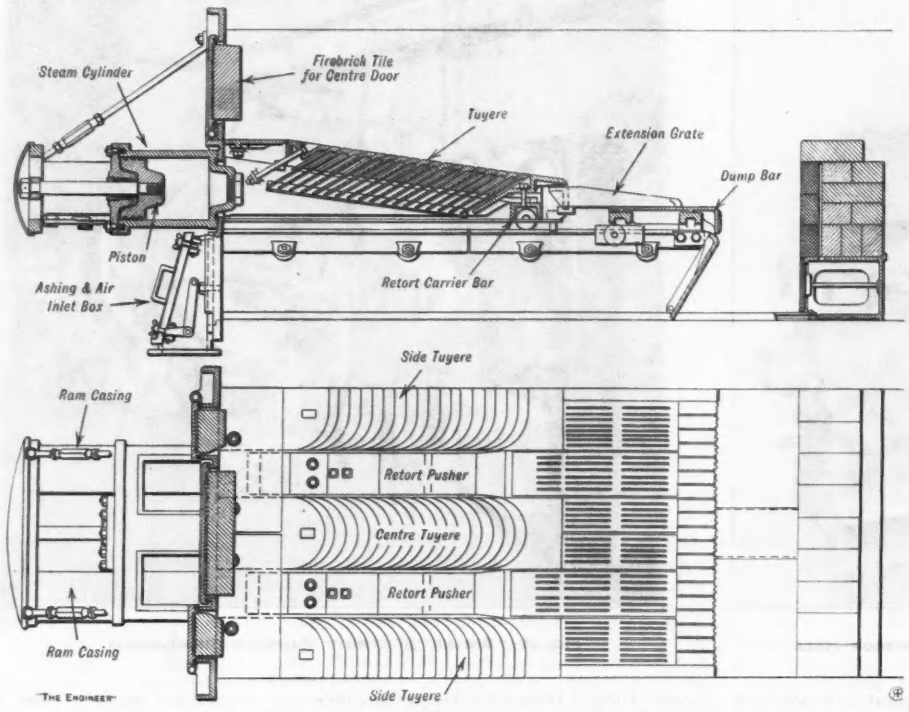


FIG. 21—ARRANGEMENT OF FLUE TYPE STOKER—BABCOCK

BABCOCK AND WILCOX, LTD.

One of the exhibits on the stand of Babcock and Wilcox, Ltd., of London and Renfrew, is the Babcock-Erith flue type stoker, shown in a sectioned corrugated flue by the subsidiary company, Erith's Engineering Company, Ltd., of 33, Farringdon-street, London, E.C.4. This stoker has been in course of development for a number of years, and the model exhibited embodies the latest improvements. In Figs. 21 and 22 we reproduce drawings of the stoker and the control mechanism, and in Figs. XXV and XXVI of the Art Supplement views of the furnace and of the front of the stoker are reproduced. The stoker employs the principles of underfeed combustion and consists of two retorts, into which the fuel is fed by a pair of reciprocating rams driven through a crosshead from a centrally placed piston and steam cylinder.

The fuel supplied to the hopper is fed by gravity into the ram casings, and is pushed forward into the retorts with each successive forward stroke of the rams. The speed is controlled by means of a mechanism designed to give an infinite variation from an extremely slow speed to a maximum speed in excess of the burning capacity of the stoker.

At the bottom of each retort specially designed pushers take charge of the coal, conveying it and underfeeding it along the entire length of the retort so that the green coal is continuously being forced upwards through a bed of incandescent fuel on to the tuyere where the air for combustion is admitted. This method of introducing the green fuel from below and upwards through the hot fire ensures, the makers claim, complete combustion of the volatiles with absence of smoke. The residual coke from the retort section passes over the extension grate or overfeed portion of the stoker, where combustion is finally completed and the refuse is discharged over the dump bar into an open pit at the end of the grate.

It will be observed that the ashpit at the rear of the stoker is not under the influence of the forced draught, but, if necessary, the opening of the ash door from the front of the stoker will allow a slight amount of air to flow through the refuse. Normally, the ash and clinker is practically combustible free, and does not require any supply of air for the burning of carbon. The bridge wall which forms the rear of the pit consists of a lower or supporting casting, the front of which has renewable plates. The bridge wall proper is constructed of an inner facing of carborundum to prevent clinker growth and an outer lining of ordinary fire-brick, an air cavity being provided between the two. Air is supplied to this cavity *viâ* the supporting casting which is connected to the main air duct by means of a pipe fitted in the flue bottom. The ash and clinker is withdrawn to the front of the boiler through the ash door.

The mechanism for controlling the speed of the stoker or the number of strokes per hour is designed to obtain the desired variation by maintaining the actual speed of the coal rams constant and increasing or decreasing the length of pause at the end of each stroke. The valve gear is set to give infinite variation between maximum and minimum, covering a range of one stroke in four minutes to eight strokes in one minute.

The mechanism comprises a small steam piston having a 5in. stroke, the movement of which is opposed by an oil displacement cylinder and piston —see Fig. 22. It consists of a 2in. bore steam cylinder fitted with a cast iron piston carrying two piston rings. Joined to the piston through a $\frac{3}{4}$in. diameter connecting-rod is another cylinder forming the oil dashpot. In order to ensure oil-tightness, hydraulic cup leathers are fitted.

A cast iron actuating arm is attached to the piston-rod and engages with a slide valve rod, the reciprocating motion of which operates a slide valve in a small steam chest above the steam cylinder which forms part of the cylinder casting. The arrangement is made clear by the drawing. The slide valve admits steam to and from each end of the main stoker steam cylinder, according to its position.

Full steam pressure is always present on one side of the steam piston with the opposite side open to atmosphere or exhaust. If the piston were free to travel unrestrained, it would rapidly move from end to end of the cylinder, but owing to the oil dashpot any sudden movement is prevented. The speed of travel of the piston is controlled by the rate at which the oil is displaced from one side of the oil cylinder piston to the other. The rate of displacement is varied by adjusting the needle valve situated at the top of the oil dashpot cylinder; the opening or closing of this valve increases or decreases the quantity of oil passing from the front of the cup leather to the back.

It is essential to move the slide valve from one side to another as quickly as possible in order to eliminate steam leakage which would occur with a slow movement, as the inlet and exhaust pipes on both sides of the main piston would communicate for the period of time occupied in moving the valve.

At the ends of the oil cylinder, by-pass ports are provided which permit the needle valve to be short-circuited for the last $\frac{3}{4}$in. of the valve piston travel, thus removing the restraint from the piston with resultant suddenly increased speed for this portion of the piston travel. This action operates the slide valve at the desired speed, as the actuating arm is free to move along the slide valve spindle except for $\frac{3}{4}$in. at the end.

Both the stoker piston and the control gear are standardised and designed for pressures up to 300 lb. per square inch. The two cylinders of the control gear (see Fig. 22) are mounted on a common base-plate, the pads of which are machined to ensure alignment.

The exhibits of Babcock and Wilcox, Ltd., include a 16in. diameter cross-over piece or expansion bend and typical high-pressure joints of the butt-weld and "Sealweld" types. In the butt-weld joint the ends of the pipes are first bevelled to the correct angle to ensure a fillet of full strength butt weld, and on assembly a thin freezing ring is inserted in the pipe immediately below the weld in order to prevent welding icicles forming within the pipe. At the bottom of the pipe a V groove is cut in the freezing ring to allow for pipe drainage.

In the case of the "Sealweld" joint, which is recommended for heavy duties, and for pressures above 450 lb. per square inch, there is a metal-to-metal joint, which forms a steam-tight joint before any welding is applied, between the smooth finished ends of the pipes. Thin fins are formed on the periphery of the pipe flanges, the lips of which are then welded together without causing any distortion of flanges. The welding seals the joint and effectively prevents any seepage or leaks which might possibly occur during the process of warming up a pipe line from the cold. If it is desired to break the joint, the sealing weld can be quickly cut off by means of a blow-pipe, and the joint resealed by welding. The joint can again be made, it is said, without having recourse to further machining.

Another Babcock exhibit, which we illustrate in Fig. XII of the Art Supplement, is the 10in. Babcock "Handor" parallel slide valve operated by Babcock-Tate electrical gear designed for alternating current, which is shown along with a series of Babcock steam and water valves. This gear can be supplied either for two-point control, for opening only or closing only, for three-point control, including the opening and the closing of a main valve, and five-point control automatically operating the opening and closing of both the main and the by-pass valves in the correct sequence. An essential feature of the Babcock-Tate design is the incorporation in the gearing between the electric motor and valve spindle of a centrifugal clutch and a dog clutch, both operated by a solenoid. The dog clutch slides on a spline on the valve spindle and engages either the motor gearing or the hand wheel as the current is switched on or off. The valve is therefore always available for ordinary hand manipulation, and at the same time the hand wheel does not revolve when the valve is being electrically operated. The function of the centrifugal clutch is to allow the motor to come up to full speed before the load is applied, and also to disconnect it as soon as the current is switched off, so that the drift of the motor does not cause the valve to overrun the limit switches and so jam in the open or closed positions. The centrifugal clutch is designed to transmit the safe maximum torque to the valve spindle, and the

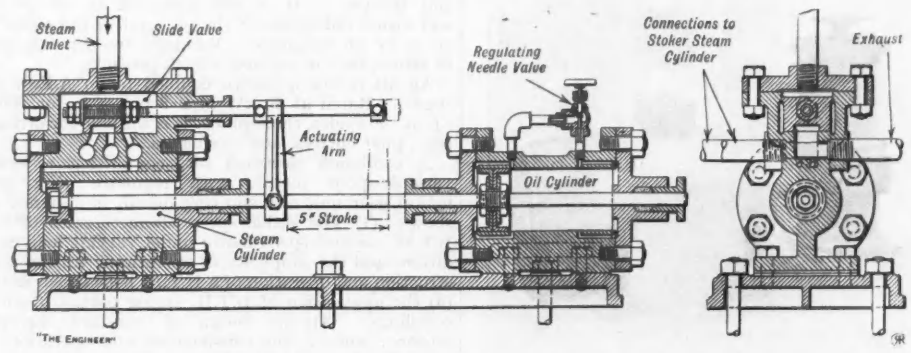


FIG. 22—OPERATING MECHANISM OF FLUE TYPE STOKER—BABCOCK

dog clutch has specially designed claws which are self-releasing should the gear be overloaded.

When current is applied to the unit, it causes the motor to accelerate against no external load until high speed is attained. Simultaneously, the solenoid pulls down the valve spindle clutch from the hand wheel to the motor gear to engage the latter to the valve spindle. This allows the centrifugal clutch to engage rapidly and a sufficiently high torque to be transmitted to the valve spindle to unseat the valve under bad conditions and traverse it in the desired direction. Should, however, the valve be almost positively jammed or seized up and the first attempt prove insufficient to unseat the valve fully, the motor is automatically uncoupled from the valve spindle and remains uncoupled for a period.

FIG. 23—WHEEL CENTRE TEST PIECE—KRYN & LAHY

During this time the motor again accelerates against no external load, and is then allowed again to engage rapidly and administer a further torsional impulse to the valve spindle. The series of hammer blows thus given will continue until the excessive load is overcome, after which the motor remains in engagement and traverses the valve spindle until stopped by the controller or limit switch. When the circuit to the unit is opened the centrifugal clutch is overcome by the action of the solenoid. This action releases the motor instantly, and simultaneously the valve spindle clutch is lifted from the motor gear to the hand wheel.

Other exhibits on the stand include an entirely new pattern of oil burner, and various examples of calorised annealing and heat-treating pots and "Calmet" alloy vessels supplied by the Calorising Corporation of Great Britain, Ltd.

KRYN AND LAHY (1928), LTD., AND J. BROWETT LINDLEY (1931), LTD.

These two associated firms, whose works are at Letchworth, Herts, share a stand with a wide variety of products on view.

We have in the past given some account of the steel-casting business of Kryn and Lahy, so it is not necessary to enlarge upon it here, except to remind readers that the Tropenas system of refining is employed, and very careful precautions taken to produce homogeneous castings. The makers have given the name of "Stronger Steel" to their mixtures, which seems justified for a material with a tensile strength of 35 to 40 tons per square inch, an elongation of at least 20 per cent. on the standard B.S.S. test piece, and a cold bend test to an angle of at least 120 deg. B.S.S. The railway wheel centre which we illustrate in Fig. 23 is evidence of the toughness of the steel. A test was carried out on it "to destruction," but it did not show any sign of cracking.

The wheel was dropped on the spaces between spokes at points 90 deg. apart on to a concrete and armour-plate foundation, and the height of the drops was gradually increased up to the limit of the crane, namely, 18ft. At the maximum height, twenty-four drops were made, and after this formidable punishment, causing the wheel to assume an almost square shape, no trace of fracture could be found.

Some of the processes in the manufacture of Kryn and Lahy steel castings will be seen in an interesting film, which will be in continuous operation throughout the Exhibition.

Besides foundry work, Kryn and Lahy are showing various machine shop products, such as the "Coborn" petrol engine, illustrated by Figs. 24 and 25.

The chief characteristic of the engine is an efficient air-cooling system which makes use of a centrifugal blower cast in the fly-wheel. Governing is effected by a simple valve in the air stream, which is direct coupled to the throttle. In spite of the lack of complication, the device gives close regulation and requires neither attention nor lubrication. Of the examples shown, two give outputs of 5 H.P., one being a standard model and the second being fitted with a reduction gear and clutch. This is a particularly neat arrangement, and makes it possible for ratios up to 4 to 1 to be obtained in either direction. Four alternative positions of the take-off shaft are also possible with this model. Another type of reduction gear is shown, fitted to a 3 H.P. engine. In this case no clutch is fitted, and two alternative shaft positions can be obtained. The engine can be supplied with aluminium crankcase, sump, main bearing covers, and oil trough, if weight reduction is an important consideration. Owing to the special care which has been taken to make this engine thoroughly foolproof and serviceable under arduous conditions, its chief application is for outdoor work, particularly for portable pumping sets. Many of the leading pump makers fit these engines as standard, and an example is shown with a 2in. pump, as supplied by Winget, Ltd., Rochester.

The Browett Lindley exhibits comprise two air compressors and a steam engine. One of the compressors, which is shown running slowly so that the working parts can be viewed through glass windows, is of the firm's standard type, having a capacity of 750 cubic feet of free air per minute, at a pressure of 100 lb. to 120 lb. per square inch, for which 145 H.P. is required at the shaft coupling at 428 r.p.m. The cylinder diameters are 17½in. and 11in., and the stroke is 8½in. The cylinders are of cast iron with exceptionally large water jackets mounted on distance pieces which separate them from the crankcase, and which also form the crosshead slides. By this arrangement the cylinder lubrication can be controlled independently of the motion work, so that economy of oil is secured and the outlet air or gas is practically free from contamination.

The valves are of the ring-plate Hoerbiger type—see Fig. 26—so arranged that the clearance space is reduced to a minimum. The lift is extremely small, and as there are no wearing parts, no lubrication is required and the valves give long life with the minimum of attention. The entire motion work is enclosed in a frame which has large doors for easy access. Forced lubrication is provided to every working part, the pump for this purpose being situated in the base plate. The latter, incidentally, is unusually wide, so as to give great rigidity, steady running, and an ample cooling surface for the crankcase oil. This machine is an example of the Browett Lindley type of compressor, which is supplied for outputs from 300 cubic feet per minute up to several thousand cubic feet per minute. The drive can be either by belt, motor, or engine, and in the case of steam-driven compressors, a separate engine can be provided, or, alternatively, the steam cylinders can be arranged in tandem with the air or gas cylinders.

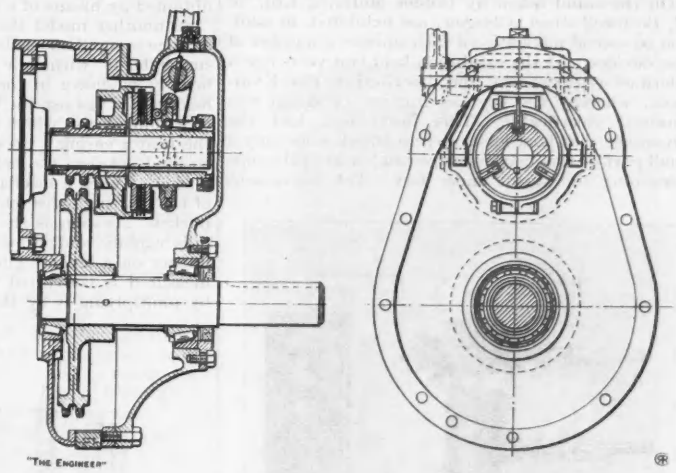


FIG. 25—GEAR-BOX AND CLUTCH FOR PETROL ENGINE—KRYN & LAHY

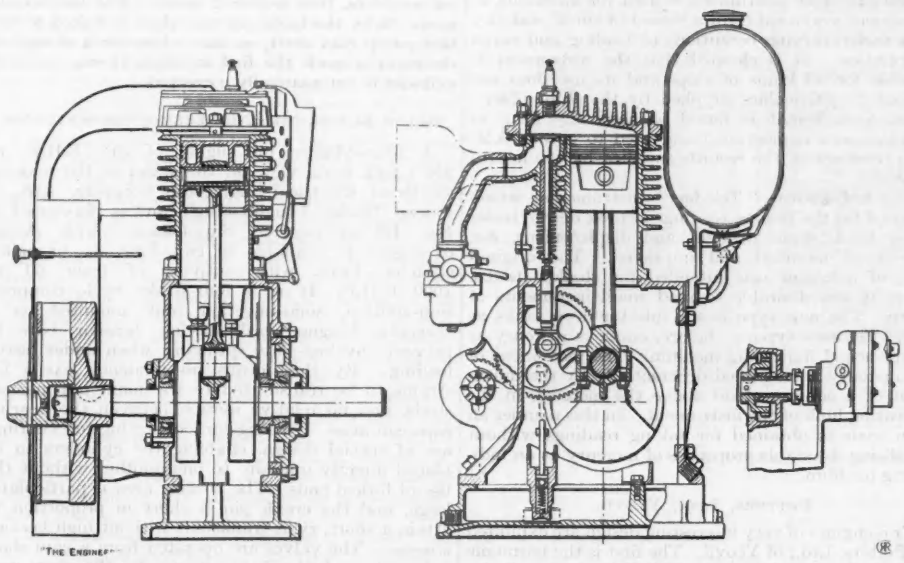


FIG. 24—CROSS SECTIONS OF "COBORN" PETROL ENGINE—KRYN & LAHY

For smaller outputs up to 200 cubic feet per minute, this company has developed an entirely new range of compressors, of which an example is shown and is illustrated by Fig. XV of the Art Supplement. It is expected that they will be in full production in the course of two or three months' time. As will be seen from the photograph reproduced, the compressor is of a novel design,. It can be driven by motor, belt or gearing. The entire working parts are enclosed in the box-shaped frame, including the fly-wheel.

The cylinders are arranged with their valve chambers as a single unit cast from a selected mixture of hard close-grained cast iron. The whole of the cylinder block is water cooled, and an easily removable cover allows for jacket cleaning when necessary. Both suction and delivery valves are of the circular Hoerbiger-Browett type, of similar design to those used in the larger compressors. It is noteworthy that the valve chambers are completely jacketed, and that the set can therefore run for exceptionally long periods at maximum load without danger of overheating. The motion work is entirely enclosed, and all bearing surfaces are lubricated under pressure by a rotary gear pump. The pressure is maintained at a constant value by an automatic release valve. Cylinder lubrication is arranged independently of the motion work. An important feature of design is that when arranged for driving by an electric motor, a rigid connection by flange mounting can be made between the motor and the crankcase. By this means it is not necessary to employ an underbase, thus saving space and expense. A flexible coupling is, of course, arranged between the two shafts.

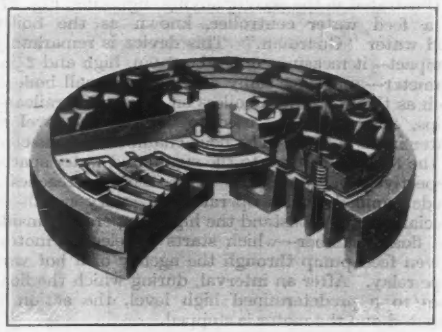


FIG. 26—HOERBIGER VALVE—BROWETT LINDLEY

The steam engine exhibited is a 90 B.H.P. "Central Valve" type, and is arranged to rotate slowly so that motion work can be seen in operation through

glass doors. One of these engines is illustrated in Fig. XXIV of the Art Supplement.

As the name implies, in this type of engine the valve chamber is arranged between the two steam cylinders as a single monobloc casting. By this arrangement the valve is situated directly over the crankshaft, thus eliminating "set" and the possibility of excessive wear. All working parts are, of course, totally enclosed, and forced lubrication is effected by means of a positive valveless pump situated in the baseplate. This engine develops its full power at 600 r.p.m.

Dobbie McInnes, Ltd.

On the stand taken by Dobbie McInnes, Ltd., of 57, Bothwell-street, Glasgow, are exhibited, in addition to special navigational instruments, a number of new devices. At the exhibition held two years ago a calorimeter was shown, and described in The Engineer, whereby the dryness fraction of steam was obtained electrically. This instrument had the advantage that heat losses were reduced, since only a small part of the instrument protruded from the pipe containing the steam under test. The instrument

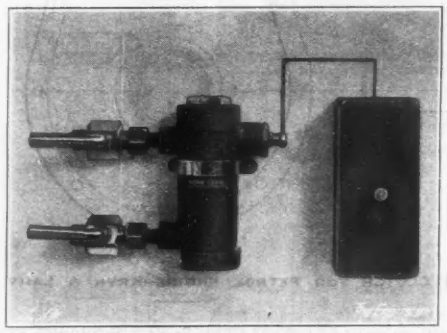


Fig. 27—Feed Water Controller—Dobbie

now being shown has been so improved that direct readings of steam quality can now be obtained on a dial, thus dispensing with the necessity for the reading of thermometers, weighing water, and calculating results from a formula.

The instrument, as before, consists of a calorimeter unit and a control panel. An electric heater in the calorimeter is enclosed in a tube within the steam main so that the steam flows through the heater and is passed on to a condenser. The amount of electrical energy supplied to the heater to bring the steam to the dry saturated condition is a measure of the wetness fraction and hence the steam quality is marked on the dial of a wattmeter in units of percentage. An electric indicator connected in series to two thermocouples in opposition—one screwed into the steam pipe and the other into the calorimeter unit on the exhaust side of the heater—indicates the instant at which the steam, after passing the heater, is just dry saturated. It is claimed that this instrument is the first of its kind to be self-indicating.

Illustrated in the accompanying engraving, Fig. 27, is a feed water controller, known as the boiler feed water "Guardian." This device is remarkably compact—it measures only about 6in. high and 2½in. diameter—and is specially suitable for small boilers, such as the waste heat boilers on oil-engined railcars, ships, &c. A float is used to indicate the level of water in the boiler. The float chamber is connected at the top and bottom to the steam and water spaces respectively of the boiler. When the float reaches a predetermined level it operates a mercury switch—a special type to withstand the high temperature inside the float chamber—which starts an electric motor-driven feed pump through the agency of a hot wire type relay. After an interval, during which the float rises to a predetermined high level, the action is reversed and the motor is stopped.

The instrument is claimed to be sensitive to small changes in water level, since there are no glands to cause friction on the float mechanism. The time lag lapsing between high and low-water level in the boiler as controlled by the instrument can be set as required, the normal ranges being from ten seconds to ten minutes. In order to prevent excessive starting and stopping of the feed pump motor, and to avoid instability as a result of the pitching and rolling of a ship or acceleration and gradient effects on a train, the time lag is usually set to approach the high limit.

A new viscometer is exhibited for the first time; this is known as the ball and bucket viscometer and is illustrated in the accompanying engravings, Fig. XIII of the Art Supplement and Fig. 28. This instrument can be used for testing fluids ranging from light oils to road pitch. It may also be used to indicate the consistency of suspensions, such as paint and emulsions, which do not exhibit a true viscosity. The instrument requires a very small quantity (about 10 millilitres) of the liquid for a complete test. It is claimed that the viscosity of an opaque fluid is as readily obtainable as that of a transparent one. In one form—that shown at the Exhibition—it operates semi-automatically, in that the test, when once started, does not require the presence of an attendant.

The fluid to be tested is placed in a small receptacle with an accurately ground bore. This part is known as the "bucket" and it is positioned in the instrument before the test so that a "ball"—a substantially spherical part having an elongated stem fixed to the body of the instrument—touches the bottom of the bore of the bucket. The bucket is then allowed to fall under its own weight. The time for it to fall clear of the ball, converted to Redwood seconds, Centipoise or other units, gives the desired viscosity. The simplest form of the instrument consists of one or more balls of various diameters, to suit different ranges of viscosity, fitted to a simple stand, with a thermometer for insertion into the ball and stem. With this form the time for the bucket to fall is obtained by means of a stop watch.

In another model the stem of the ball—of which a range is supplied—is held at the top by a cap which suspends it within a thermostatically controlled heater, as shown in the engravings. The bucket is held gently against the bottom of the ball by means of a control disc which mates with a female cone in the heater casing. Good thermal contact is thereby ensured between the heater and the fluid within the bucket. When a mechanical clock is used, operation of the starting lever releases the conical disc and the bucket. As soon as the bucket is clear of the ball it falls rapidly and stops the clock by means of the impact on a lever. The time interval in seconds so measured is converted to absolute Centipoise units by multiplying it by the constant for the particular

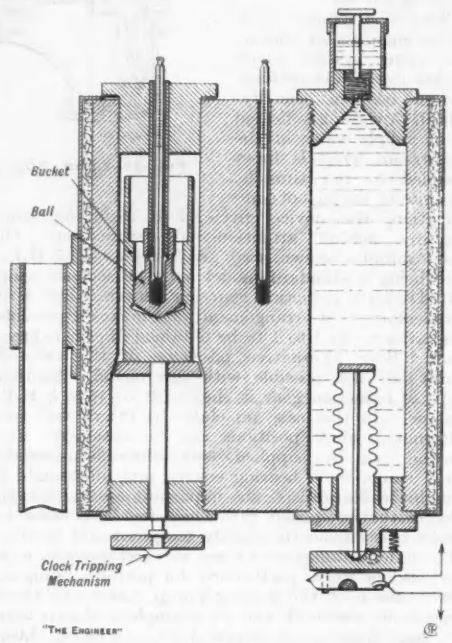


Fig. 28—Ball and Bucket Viscometer—Dobbie

ball selected for the test. A third form of the viscometer can be used with a synchronous electric clock, the starting and stopping of which is effected electrically.

Among the navigational instruments exhibited, the "Stabilograph" is one which has been recently improved. This instrument is used for obtaining in permanent graphical form a record of ships' stability tests under varying conditions of loading and cargo distribution. It is claimed that the instrument is suitable for all kinds of ships and its use does not depend on particulars supplied by the shipbuilders. Metacentric height is found without any form of calculation, a nomogram being used to obtain G.M. from readings on the records supplied by the instrument.

The well-known "Teledep" instruments, which are used for the remote readings of tank depth, boiler water level, ships' draught and displacement, &c. have been modified and improved. The original type of indicator was intended for shallow tanks, where it was desirable to read small increments of depth. The new type is suitable for deep tanks as well. The new type, as before, employs mercury as the principal indicating medium. The movement of the mercury is magnified differentially by the movement of a column of oil above the mercury in the indicating limb of the instrument. In this manner an open scale is obtained for taking readings without sacrificing the stable properties of mercury as an indicating medium.

Petters, Ltd., Yeovil.

Two engines of very interesting design are exhibited by Petters, Ltd., of Yeovil. The first is the harmonic induction engine shown as a 16 B.H.P. single-cylinder unit, direct coupled to an electric generator. This novel form of two-stroke design was described in The Engineer of December 25th, 1936, page 695. It will be recalled that the system used differs in principle from other types in that the exhaust gases are expelled from the cylinder and a new charge of clean air introduced, solely by taking advantage of the harmonic pulsations in the exhaust system. These pulsations closely resemble the pulsations of a sound wave in an organ pipe. The engine has no blower, nor does it employ crank case pressure, neither has it the idle strokes of the four-stroke cycle engine. As a result, the power of an engine of any given dimension is greatly increased.

The other engine of particular interest is illustrated in Fig. V of the Art Supplement. This marine unit of the blower scavenge type is an excellent example of the progress made in two-stroke design. The engine, which has an output of 300 B.H.P. and a moderate piston speed, moderate mean effective pressure, and low stresses throughout, has been specially designed as a marine engine with all parts of the reversing gear, bed-plate extensions, &c., forming integral parts of the engine as shown in the illustration. The leading features of the engine are monobloc construction with separate detachable cylinder heads, removable liners, and oil-cooled pistons fitted with spherical small-end bearings.

The bilge and circulating water pumps, and the air compressor are built into the forward end of the engine and are gear driven at a slow speed. Having adequate capacity, these pumps are provided with very large air vessels on both suction and delivery sides to eliminate water hammer. They are also fitted with pressure relief valves and the actual water valves are very easily accessible. All working parts exposed to the action of sea water are made of gun-metal or other anti-corrosion alloy. A fuel transfer pump for transferring the fuel oil from the main tanks to the daily service tank is built on to the engine. A Michell water-cooled thrust bearing is fitted on the shaft.

The spherical small end bearing and oil-cooled piston arrangements are claimed to give this engine exceptional capacity for carrying heavy loads for prolonged periods. The fuel oil system is arranged so that if the lubricating oil pressure falls, the fuel is cut off and the engine brought to rest. An interesting device has also been incorporated in the fuel system which enables the load distribution among cylinders to be checked at any time, thus indicating when and where adjustments are required. A full forced feed lubricating oil system has been adopted in this totally enclosed design. The direct reversing gear and control system is of interest, particularly for coastal or harbour installations. Manœuvring is effected by means of compressed air, and all operations are controlled by a single hand wheel. The controls are grouped conveniently round this hand wheel with the revolution counter, scavenge air, oil and starting air pressure gauges grouped immediately above the indicator scale. With the air supply available, the engineer has only to turn the hand wheel until its pointer indicates the "start" position, when the engine immediately accelerates. Thereafter all navigational orders are given immediate effect by the engineer turning the control wheel until its pointer indicates the required position, the engine responding instantly to all changes.

When reversing, the hand wheel and pointer is simply rotated back through the "Ahead" position into the "Astern" section of the indicator scale, the engine follows this movement. Full speed ahead to full astern, or *vice versâ*, is effected in six seconds. This performance is obtained by the use of an ingenious "air braking" system to secure rapid deceleration, which in conjunction with a safety device ensures that the engine first comes to a standstill before it can be restarted in an opposite direction of rotation. During this operation the fuel is automatically cut off and the air used is put into the air receivers, thus avoiding waste. The mechanism operated by the hand control wheel is linked to the fuel pump cam shaft, so that whenever a change of direction is made the fuel injection timing for each cylinder is automatically corrected.

Brush Electrical Engineering Company, Ltd.

A four-cylinder oil engine of 312 B.H.P. at 350 r.p.m. is on view on the stand of the makers, the Brush Electrical Engineering Company, Ltd., of Falcon Works, Loughborough, and is illustrated in Fig. III of the Art Supplement. This design of engine is available in two, four, six, or eight-cylinder form, with outputs of from 60 to 1000 B.H.P. It is a four-stroke cycle compression-ignition, solid-injection unit, mounted on a specially designed bed having tension bars to prevent any bed-plate springing when under heavy loading. By this means no tendency exists for strains to be transmitted to the main bearing cap studs, and no relative motion between the bearing caps can arise. The big-end connecting-rod bearings are of special design, enabling the cylinders to be placed directly opposite to one another without the use of forked ends. The bearing area is particularly large, and the crank pin is short in proportion to attain a short, rigid crankshaft without high bearing stresses. The valves are operated from a cam shaft below the cylinder heads driven by the skew gear drive visible in the illustration. The inlet valves are directly above this shaft at right angles to the centre line of the cylinder, a position which makes them very accessible and, at the same time, enables clean, cool air to be drawn in from the "freest" part of the engine-room. The exhaust valves are placed immediately above the inlet valves in water-cooled cages. They are thus well cooled, thoroughly accessible, and in a position to minimise the carbon

formation. The theoretical valve arrangement is good as it provides thorough scavenging of the cylinder. The injection system is direct, the pumps being grouped at the timing gear end of the crankshaft and operated from the cam shaft driving shaft. Variable injection timing is by hand control. All working parts are totally enclosed, and force lubrication is fitted throughout the engine, no points requiring hand oiling. Accessibility is always a feature of the horizontal engine, and in this case has been carefully thought out, the pistons, for example, being removed in a few minutes without disturbing any connections or pressure joints. Fuel consumption has been studied, and according to recent tests a figure of 0·357 lb. per B.H.P.-hour was attained. For continuous running service a conservative figure for the full load brake mean effective pressure of 66·6 lb. is used, and a piston speed of 833·3ft. per minute, as given by test results.

W. H. ALLEN, SONS AND CO., LTD.

Few exhibits in Olympia are more representative than the display of machinery arranged by W. H. Allen, Sons and Co., Ltd., of Bedford. This display has been prepared to illustrate the specialised activities of the company in the design and construction of a most varied range of power plant, both oil engine and steam driven, pumping machinery and electrical equipment for marine, power generating, and industrial uses.

The largest exhibit on the stand, and possibly the

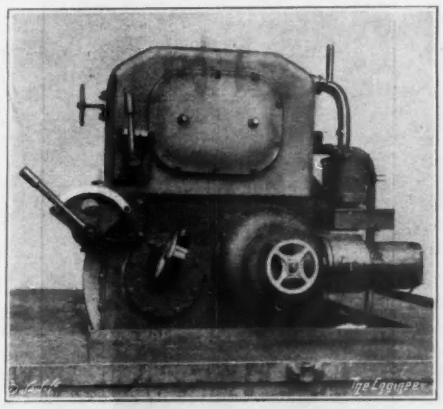


FIG. 29—OIL ENGINE CONTROL GEAR—ALLEN

largest power unit in the Exhibition, is a six-cylinder 582 B.H.P. vertical oil engine, working on the airless injection principle, which we illustrate in Fig. II of the Art Supplement. This engine is representative of the firm's larger types which are supplied for powers up to 1200 B.H.P. It is also typical of the engines supplied with D.C. generators for auxiliary power purposes on board ship.

The cylinder block of the engine is formed in a single casting bolted to a deep section bed-plate, and large inspection doors on the front and back of the crank case, affording easy access to the connecting-rod and main bearings, are provided. A medium-pressure forced-feed system of lubrication is used, which supplies the main bearings, crank pins, and gudgeon pins, whilst the cam shaft runs in an oil bath with positive supply. In the lubricating oil circuit the oil is constantly drawn from the engine base by an engine-driven gear type pump, and is passed through a double-compartment filter and cooler before reaching any moving parts. The complete system is so arranged that it can be primed before starting by operating the main pump by hand. The pistons are supplied by a mechanical sight-feed lubricator, which has an adjustable feed to each piston.

A feature of the design is that all the materials used for the different parts have been specially selected for the most exacting conditions under which the engine may have to operate, and considerable attention has been paid to the details of design, in order to meet the needs of all classes of engineering work.

The inlet and exhaust valves, which operate vertically, are interchangeable and have removable cages, that for the exhaust valve being water cooled. An independent fuel pump with relief valve is provided for each cylinder, the pump being adjacent to the fuel injector. All the pipes leading to the injectors are short and of equal length, thereby ensuring that the distribution of fuel to each cylinder is equal at all loads. The pumps are of strong construction and are easily accessible for adjustment, while the fuel injectors are of the automatic water-cooled differential piston pattern, which provides, the makers claim, efficient combustion over the load range of the engine.

The centrifugal type governor is designed to regulate automatically the fuel supply at all loads, and its adjusting gear enables the engine speed to be varied while running. On the unit exhibited the speed of the engine can also be adjusted by a push button controlled reversible electric motor mounted on the governor casing.

This design is shown in the engraving, Fig. 29, which also shows the starting lever, the fuel cut-off lever, the air starting valve, and tachometer, which, it will be noted, are all conveniently grouped at the fly-wheel end of the engine.

The cam shaft is driven through a silent running duplex roller chain from the crankshaft at the fly-wheel end, and the case-hardened steel cams operate the valve levers through short push rods provided with hardened spherical ends. The levers are arranged overhead and are carried on roller bearings. Engines of the same bore and stroke and of similar design to the unit above described are supplied in three, four, and five-cylinder sizes.

The other Allen oil engine exhibit—which we do not illustrate—is a six-cylinder, 180 B.H.P. unit coupled to a 120-kW Allen D.C. generator. The set is designed for service on board ship, and the engine, which is of the vertical four-stroke cycle airless-injection type, is typical of the firm's medium sizes for marine purposes, as well as for electrical and mechanical power services on land.

The cylinder block and engine base consists of a single casting of " C " frame design, and an aperture in the front gives easy access to the crankshaft, cam shaft, and bearings, the aperture being covered by a longitudinal plate on which inspection doors are fitted.

The steam-driven exhibits include two turbo-generators, one of 100-kW output and the other of 80-kW output; a 175-kW steam engine-driven generating set, a turbine-driven main circulating pump, of the centrifugal type; and a turbine-driven main circulating pump of the axial flow type.

Both the 100-kW and 80-kW turbo-generators are specially designed for auxiliary service on board ship. Each machine consists of a single-stage impulse type turbine designed to operate at high efficiency driving an Allen D.C. generator through single helical reduction gears, which are lubricated under pressure from the turbine oil system. The sets are noteworthy for their compactness and robust construction. The specially selected materials used for many parts of the turbines are designed to ensure long working life under marine service.

The turbine of the 100-kW set is designed for operating at a steam pressure of 225 lb. per square inch, with a total temperature of 600 deg. Fahr., and exhausting against a back pressure of 10 lb. per square inch, or, alternatively, to a vacuum of 28½in. The generator is of the compound-wound, direct-current, multi-polar open type, running at a speed of 1500 r.p.m. and designed for a voltage of 220.

The turbine of the 80-kW set shown in Fig. XXI of the Art Supplement, operates at a steam pressure of 225 lb. per square inch with a total temperature of 620 deg. Fah., and exhausts against a back pressure of 25 lb. per square inch, or, alternatively, to a vacuum of 28in. The generator of this set is of the direct-current, shunt-wound, pipe-ventilated type, running at a speed of 1250 r.p.m., and designed for a voltage of 220. It is fitted with a rotatable magnet frame having loose poles and single end shield bearing.

to all the moving parts and to the governor gear by a valveless type pump, the oil passing through a strainer which is easily removable for cleaning. A special feature of the design is the absence of oil pipes to the main bearings, thereby facilitating the easy removal of the bearing caps. The engine is designed to operate at a steam pressure of 180 lb. per square inch, with a total temperature of 600 deg. Fah. and to exhaust against a back pressure of 10 lb. per square inch. The generator is of the Allen direct-current, compound-wound, multi-polar, open type, running at a speed of 425 r.p.m.

Other exhibits include a horizontal pumping unit driven by a steam turbine, which is generally similar to the circulating water pumps recently supplied by

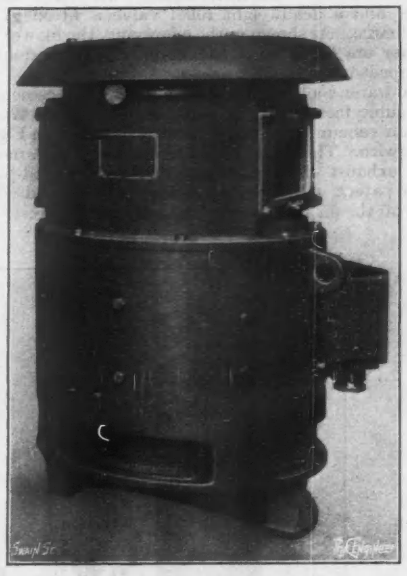


FIG. 31—50 H.P. VERTICAL-SPINDLE MOTOR—ALLEN

the firm for the new liners of the P. & O. and Orient Line Company, already described in THE ENGINEER. A turbine-driven axial-flow pump is also shown.

The electrical exhibits of W. H. Allen, Sons and Co., Ltd., of Bedford, are mainly for marine service. There are four D.C. generators. One is rated at 120 kW and is coupled to a 180 H.P. oil engine. Two machines, rated at 100 kW and 80 kW, are driven by steam turbines and a 170-kW dynamo by a steam engine. The display of D.C. motors includes enclosed ventilated, drip-proof pipe ventilated, deluge

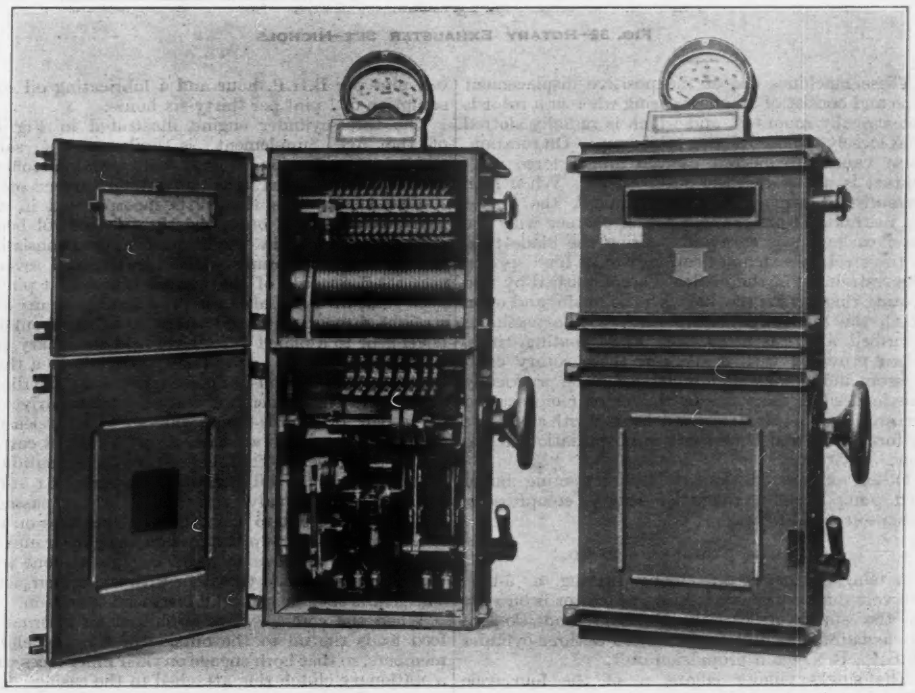


FIG. 30—VARIABLE-SPEED MOTOR CONTROL PANEL—ALLEN

The steam engine-driven marine generating set illustrated in Fig. XXIII of the Art Supplement, has a continuous output rating of 175 kW. The engine is of the vertical, enclosed, forced lubrication, two-crank compound type, and all working parts are totally enclosed in a cast iron casing which forms the engine trunk, the casing being provided with inspection doors giving easy access to the interior. The casing supports the distance pieces and cylinders, and is bolted to a bed-plate of rigid design and construction, which forms the housing for the main bearings and also serves as a reservoir for the lubricating oil. Forced lubrication is supplied and totally enclosed machines, with and without self-contained coolers. Ball and roller bearings are normally fitted, but sleeve bearings with oil ring lubrication are provided when required. The brush gear is claimed to leave nothing to be desired. Carried in non-ferrous cast boxes attached to insulated arms, the brushes can be adjusted in all directions, and the current pressure can readily be secured. In Fig. 31 is shown a 50 H.P. vertical-spindle drip-proof motor.

Control gear exhibited consists of drum and automatic type panels for constant and variable-speed motors. An example of the former is shown in Fig. 30. The hinged doors of the steel plate cases are

easily removed, and are fitted with inspection windows. Inspection and maintenance are facilitated by the possibility of removing all parts from the front, and the unit construction enables the panels to be built to meet special requirements.

NICHOLS COMPRESSORS, LTD.

On the stand of Nichols Compressors, Ltd., of 303–304, Finsbury-pavement House, London, E.C.2, is shown an air-cooled rotary vane type blower, illustrated in Fig. XVIII of the Art Supplement. This machine will compress air at the rate of 400 cubic feet per minute at a pressure of 4 lb. per square inch. The set is directly driven by means of a 12 H.P. electric motor and runs at 790 r.p.m. Vokes "Protectomotors" are fitted to the inlet and a deadweight relief valve is fitted to the discharge. As shown in the engraving, the blower and motor are fitted on a common bed plate, forming a compact unit.

A water cooled exhauster, with a displacement of 68 cubic feet per minute of free air at 1450 r.p.m., and a vacuum of 25in. of mercury, is shown in Fig. 32 herewith. This machine is driven by a 4 H.P. motor. An exhaust silencer is mounted on the bed-plate, and patent wick-feed lubricators are provided which cut off the oil supply when the machine is at rest.

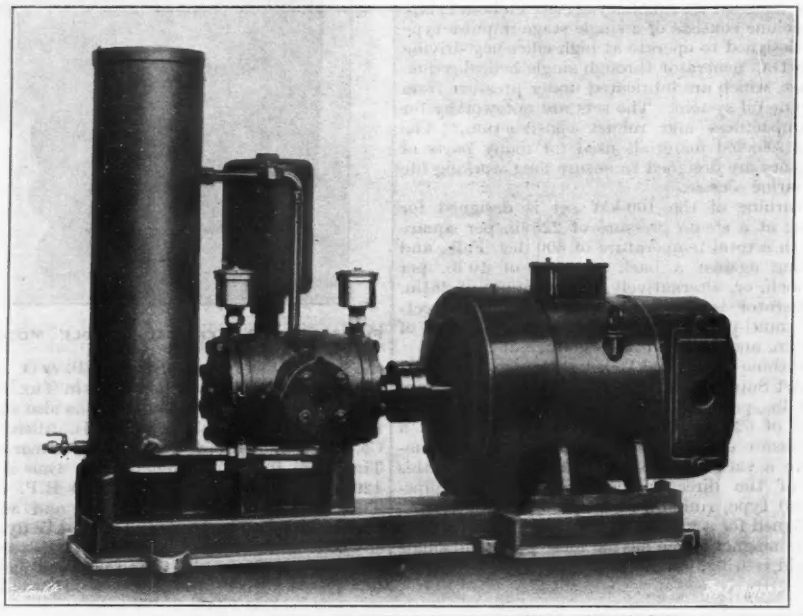


FIG. 32—ROTARY EXHAUSTER SET—NICHOLS

These machines are of the positive displacement type and consist of an outer casing wherein a rotor is excentrically mounted, and which is radially slotted so as loosely to house sliding steel vanes. On rotation, these vanes are ejected by centrifugal force until contact is made with the outer casing. When high pressures or large vacua are required, the blades are restrained from making actual contact with the outer casing so as to avoid wearing the blade tips, as these rotary machines can be run at high speeds. The restraining of the blades is accomplished by two floating rings which revolve with the blades and upon which the blade tips bear. Each of the machines described above is fitted with these floating rings. When provided with a silencer, these rotary compressors and exhausters are claimed to be practically noiseless, since there are no valves or reciprocating accessories. The air stream is delivered with an almost uniform flow, and thus there is no pulsation in the flow.

Other exhibits shown are a direct-acting boiler feed pump and a range of rotary compressors, exhausters, and blowers.

RUSSELL, NEWBERY AND CO.

A single-cylinder oil engine driving a 5-kW, 110-volt ship's auxiliary lighting generator is on view on the stand of Russell, Newbery and Co., of Altrincham, Manchester, as well as a three-cylinder 30 H.P., R.N. main propulsion unit.

The single-cylinder engine is of the four-cycle totally enclosed hand starting type, no auxiliary starting mechanism in the way of glow plugs, cartridges, &c., being necessary. The combustion chamber has an inclined injector at the top and the walls are inward curving and terminate in a plug fitted to the crown of the piston so that the combustion head bore is considerably smaller than the cylinder bore proper. The valves are at right angles to the centre line of the cylinder and form a large part of the walls of the combustion chamber. They are push-rod operated through rockers lubricated by special oil trays on either side over each valve. The inlet valve is removable complete with its seating and the exhaust valve has a quickly detachable spring, enabling it to be removed through the inlet valve orifice. Both the cylinder head and the cylinder block are detachable, which makes overhaul in a confined space easy.

The fuel pump is operated from the cam shaft with a speed control screw and locknut adjacent, near which is fitted the stopping and priming lever. As the oil filler for the crank case is immediately beneath all attentions to the engine are to one side only. The crank case is designed as for marine emergency units, with ample capacity to allow the engine to run at any inclination. The cylinder liner is of the wet type. Oil seals are fitted at each end of the crankshaft, which has forced lubrication, also carried to the big end, gudgeon pin and the valve feed tray. A plunger pump operated from one end of the crankshaft provides the necessary pressure. The normal running speed is 1000 r.p.m. and with a bore and stroke of 4½in. by 6in. a twenty-four-hour output of 8 B.H.P. is attainable with a fuel consumption of about 0·4 pint per B.H.P. hour and a lubricating oil consumption of 1 pint per thirty-six hours.

The three-cylinder engine, illustrated in Fig. IV of the Art Supplement, is built to the same general specification. The fluid-operated control gear provided has the advantage over other similar mechanisms that it is incorporated in the gear-box as a unit only, the throttle control being external, as shown in the illustration, and consisting of rods and bell cranks. The forward and reverse gear itself consists of the normal differential pinion type gear, in which ahead is provided by means of a straight-through drive and astern by a drive from one bevel gear to a planet type bevel held stationary and thence back with a one-to-one speed ratio to a third bevel, the three bevels, of course, reversing the direction. The engagement of the alternative drives is by a pair of double-faced wide-angle self-releasing cone clutches, which are carried on the planet carrier of the gear itself. The oil pressure for actuation is brought from the oil pump in the gear-box sump through a control valve and thence through passages drilled in the shaft to the two annular spaces on the inner side of these two clutches on the carrier and by causing them to move outwards engages the one with the driving shaft and the other with the driven shaft. The gear is then locked solid for ahead operation.

When the control valve is shifted an alternative feed leads the oil to the outside of the two clutch members, so that both engage on their inner faces with a stationary clutch ring attached to the casing. The planet is thus locked and the drive takes place through the gears, thus bringing in reverse. When the control is moved further to "forward" or "reverse" the engine throttle is opened. The actuation pressure is about 30 lb. and neutral is produced by releasing this pressure to a by-pass, thus releasing the clutches and the throttle to "tick-over." At the same time, a small auxiliary clutch, normally held out of action by the oil pressure, locks the tail shaft to the casing to prevent creep. Naturally, when a quick reverse is made the oil pressure does not have time to release this clutch, so that it does not impede reversal.

The control valve may be operated by any form of distant control, such as a telegraph, as it requires no force to actuate. The gear-box and control occupy no more space than the normal reverse gear-box, and are self-contained, avoiding the dangers of external piping and auxiliary equipment.

CLARKSON THIMBLE TUBE BOILER COMPANY, LTD.

The main exhibit on the stand of the Clarkson Thimble Tube Boiler Company, Ltd., of Australia House, Strand, W.C.2, is the full-size model of the Clarkson concentric composite boiler illustrated in Fig. XXVII of the Art Supplement. Part of the casing of the boiler has been removed in order to show the principal features of construction, which include a patented centre air heater for the oil burner. The boiler has a diameter of 7ft. 6in., with a total height of 13ft., and the design adopted is such that steam can either be produced from the exhaust gases of an oil engine or by oil firing. If desired, both methods can be used simultaneously.

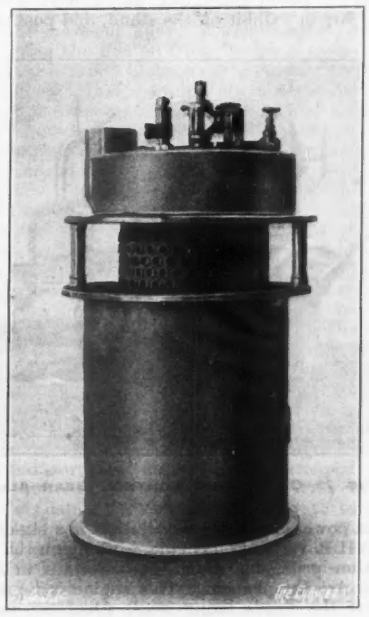


FIG. 33—BURNER BOILER—CLARKSON

As will be seen from our engraving, the exhaust pipe of the engine can be connected vertically or horizontally as may be convenient. The heating surface provided in this boiler is such that a designed output of 1350 lb. of steam can be raised by direct oil firing, and about 850 lb. of steam from the waste heat of exhaust gases. When desired fully automatic control can be supplied so that in case of a sudden falling off of the volume of exhaust gases, loss of heat is immediately compensated by increasing the oil supply to the burner.

By means of photographs, the firm is showing other types of boilers for land, marine, and railcar service, including a special form of waste heat boiler designed to operate on the forced circulating system. Details are also available of a combined silencer and boiler which is being successfully used for the heating of railcars and trailers.

A further interesting feature of the stand is the display of a representative range of thimble tubes, both new and taken from boilers in service. The tubes are arranged to demonstrate the freedom from scale and corrosion which, it is claimed, is a characteristic of the thimble tube principle.

As mentioned in our article on the exhibits of Babcock and Wilcox, Ltd., there is shown on that stand a new type of Clarkson burner boiler illustrated in Fig. 33 herewith. Our engraving shows the upper part of the boiler slightly raised in order to indicate the arrangement of thimble tubes. It will be seen that the boiler is entirely water jacketed and arranged so that both sides of the heating surface are accessible for inspection or cleaning. There is a centrally placed oil burner on the top of the boiler, and several new features have been embodied in the design to enable this new boiler to be arranged for combined oil firing and waste heat recovery, which adapts it for use in railcars and for other special purposes.

COMPRESSORS AND BLOWERS EXHIBITED AT OLYMPIA

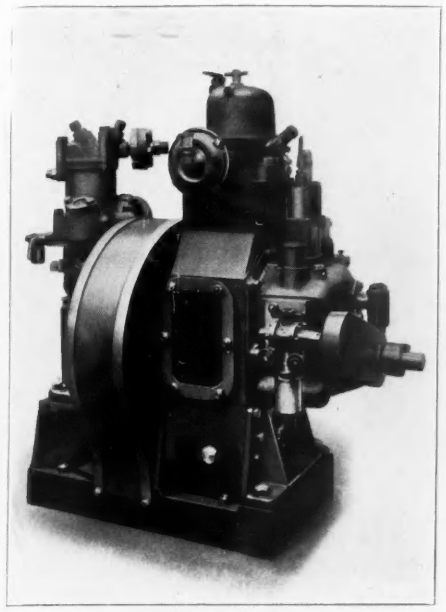


Fig. XIV—Auxiliary Compressor Set—Crossley

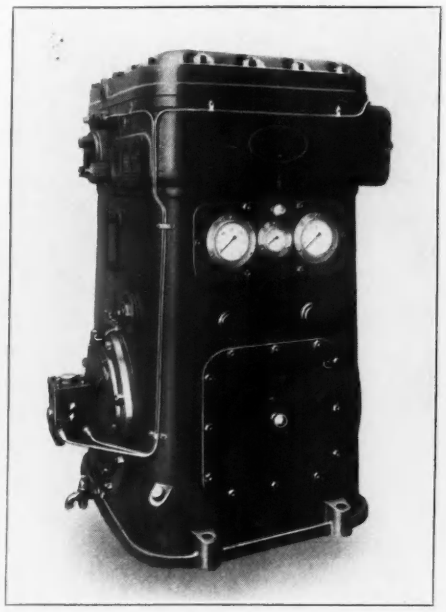


Fig. XV—Monobloc Compressor—Browett Lindley

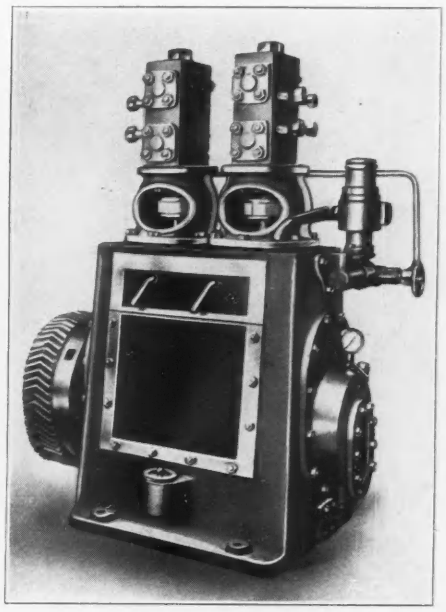


Fig. XVI—Two-Cylinder Compressor—Haslam

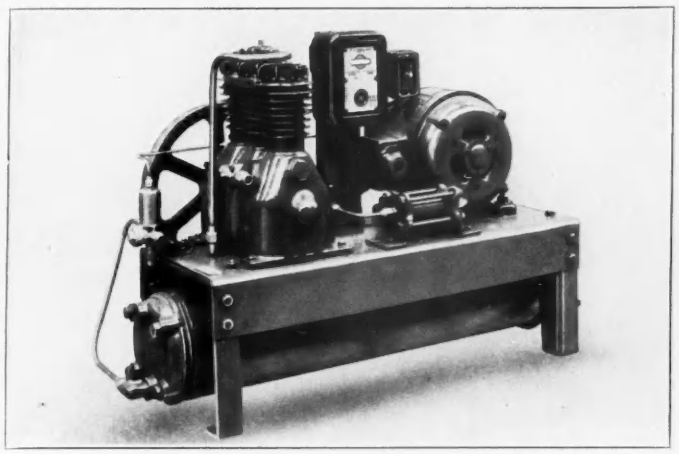


Fig. XVII—Refrigerating Compressor Set—Sterne

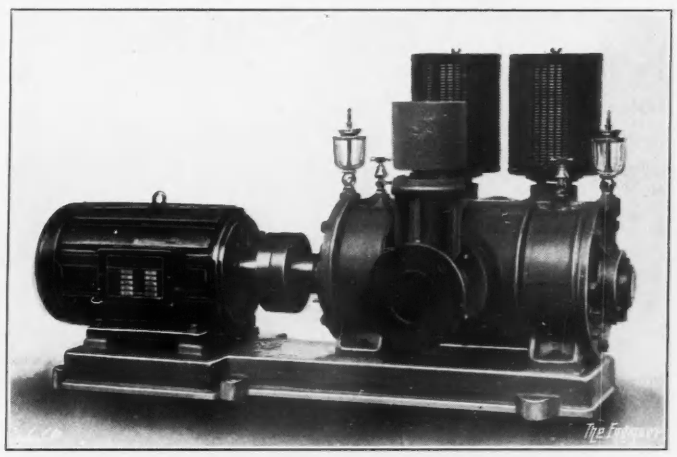


Fig. XVIII—Rotary Blower—Nichols

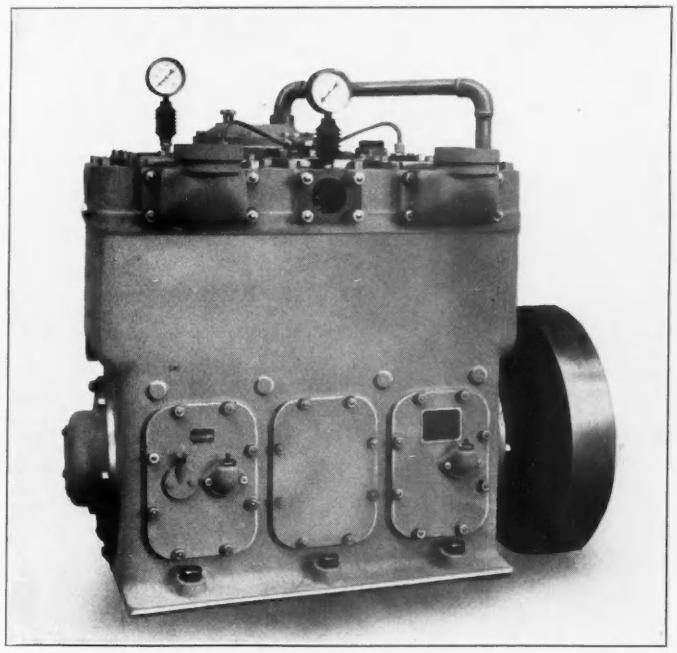


Fig. XIX—Two-Stage Intercooler Air Compressor—Reavell

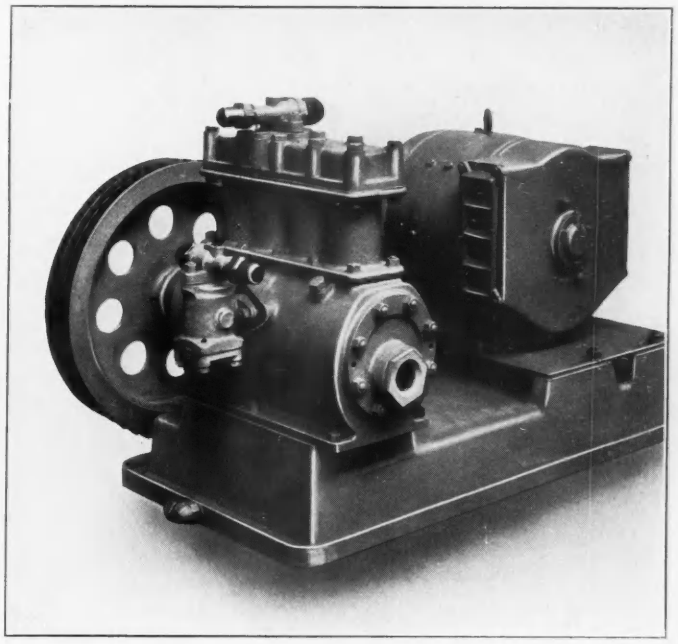


Fig. XX—Small Compressor Set—Hall

STEAM MACHINERY EXHIBITED AT OLYMPIA

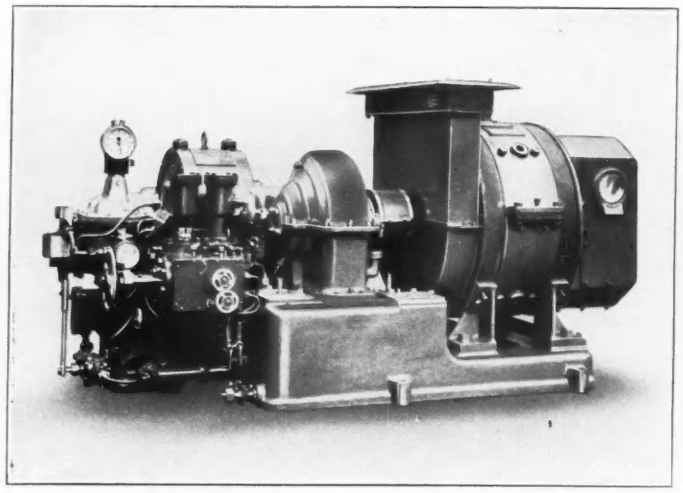


FIG. XXI—80 KW GEARED TURBO-GENERATOR—ALLEN

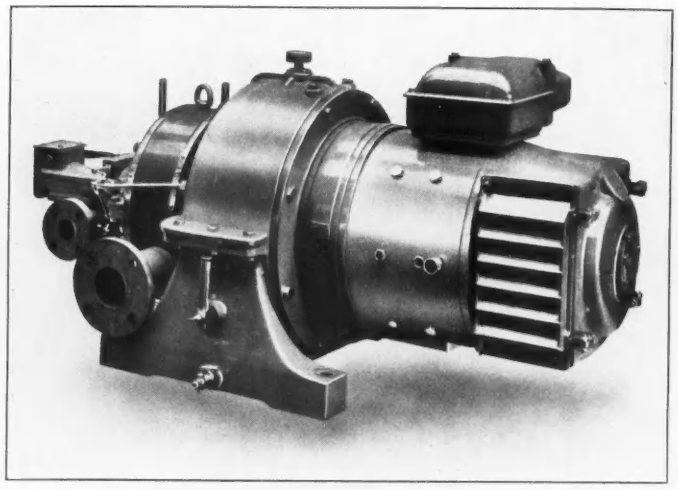


FIG. XXII—10 KW GEARED TURBO-GENERATOR—B.T.H.

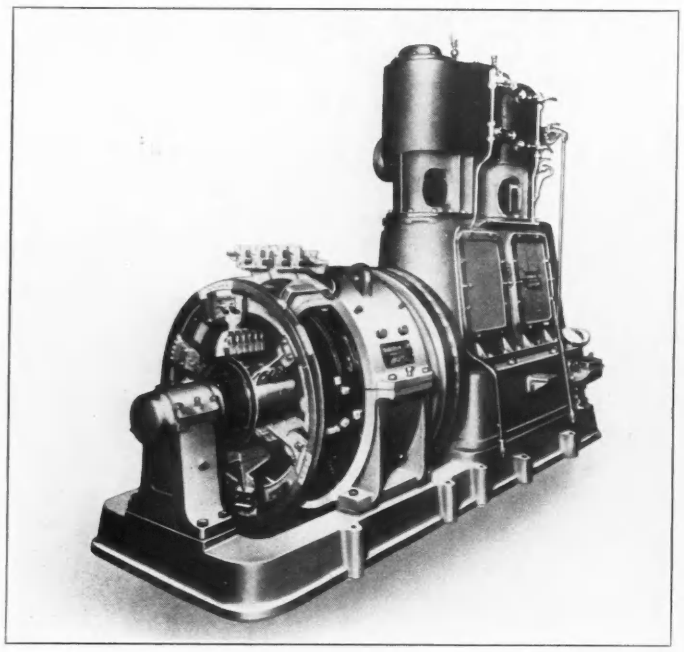


FIG. XXIII—175 KW STEAM GENERATING SET—ALLEN

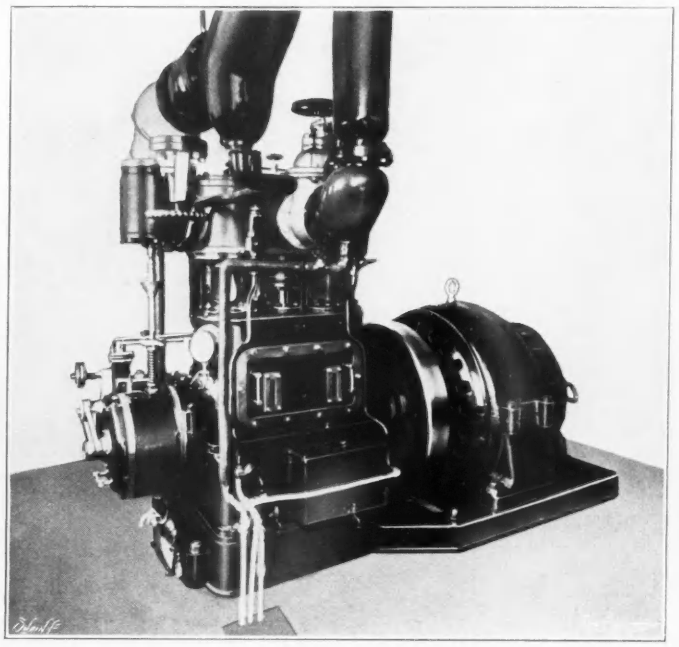


FIG. XXIV—90 B.H.P. STEAM ENGINE AND GENERATOR—BROWETT LINDLEY

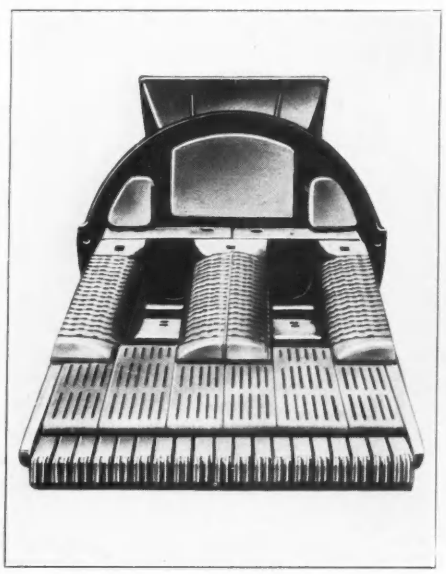


FIG. XXV—FLUE TYPE STOKER—BABCOCK

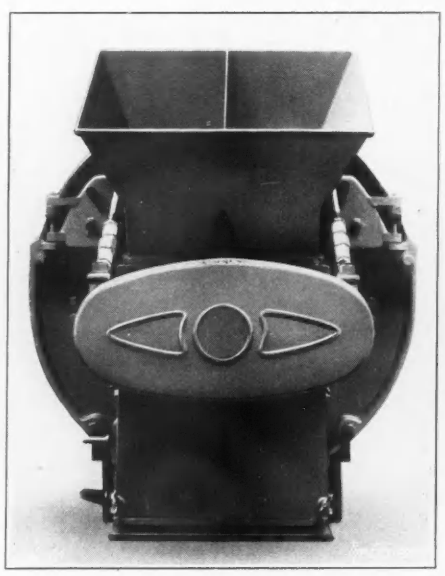


FIG. XXVI—FRONT OF STOKER—BABCOCK

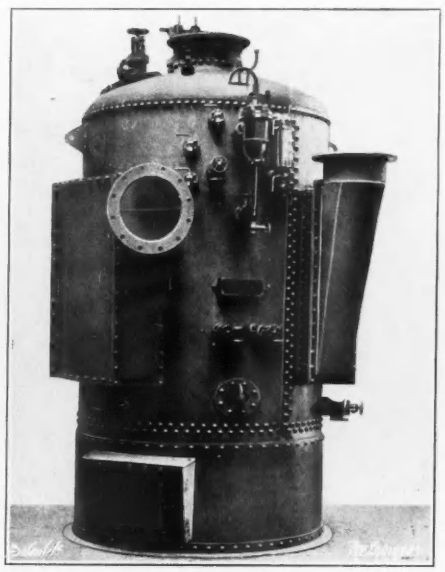
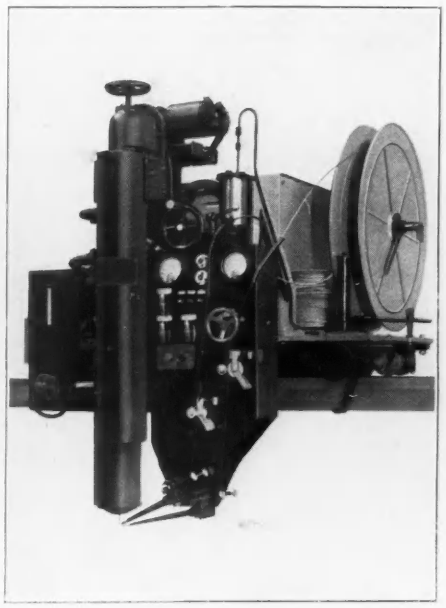
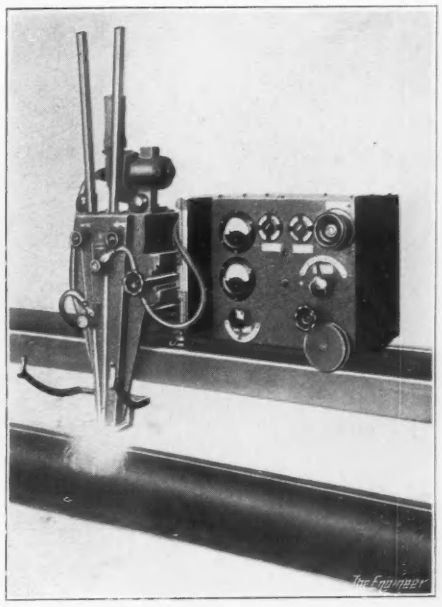
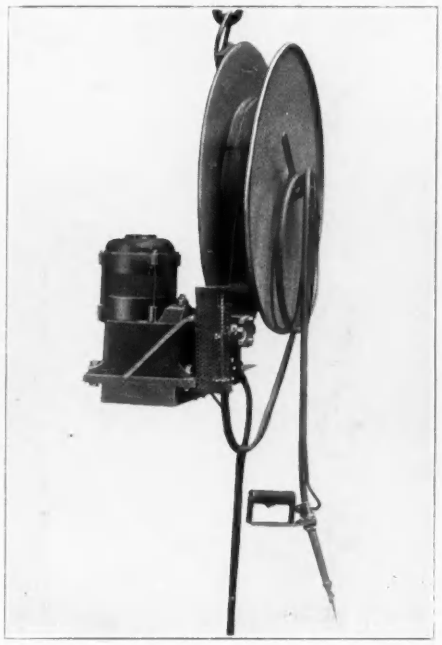


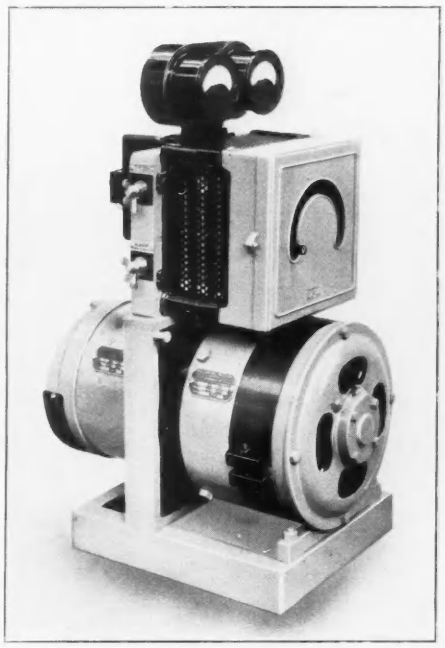
FIG. XXVII—WASTE-HEAT AND OIL-FIRED BOILER—CLARKSON

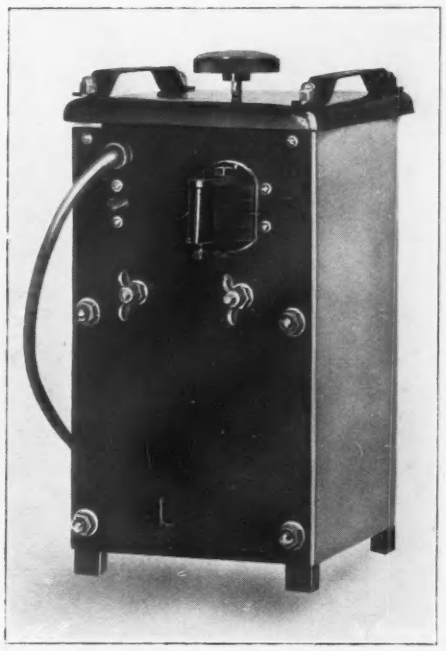
WELDING MACHINERY EXHIBITED AT OLYMPIA

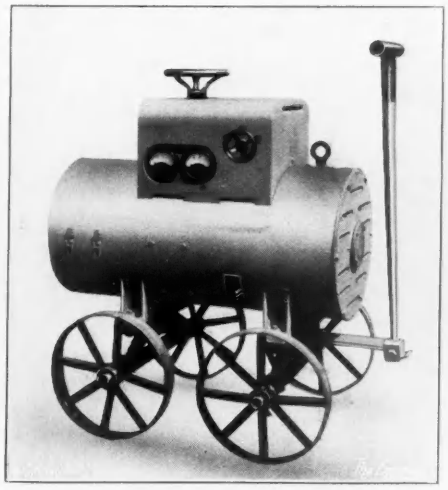


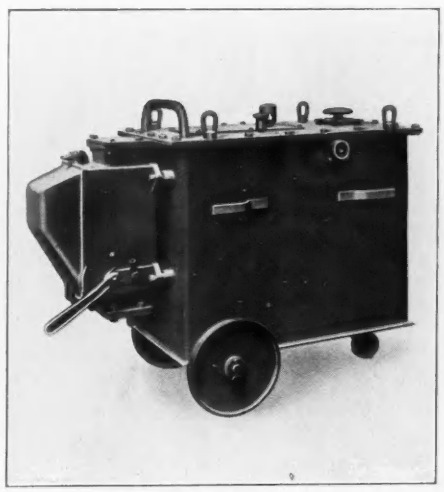












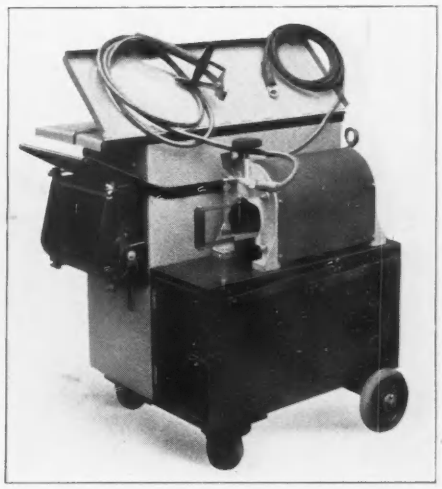


FIG. I—SPOT WELDING MACHINE—SOAG

FIG. II—CARBON ARC WELDING HEAD—PETERS

FIG. III—AUTOMATIC WELDING HEAD—WELDING SUPPLIES

FIG. IV—SEMI-AUTOMATIC WELDING HEAD—PETERS

FIG. V—LIGHT WELDER—MUREX

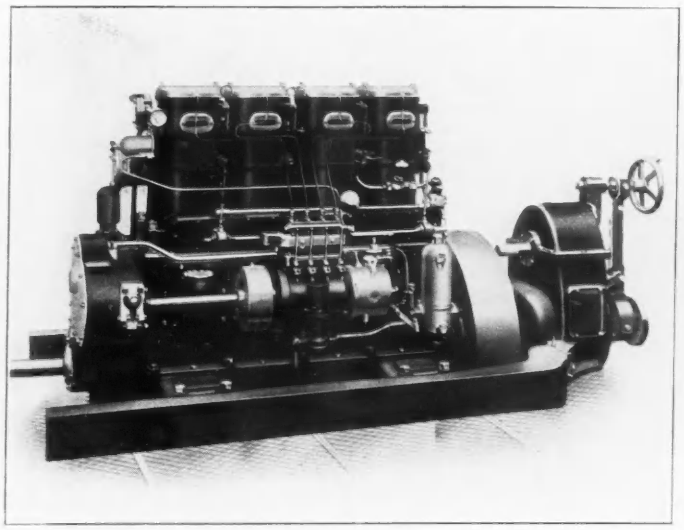
FIG. VI—A.C. WELDER—PETBOW

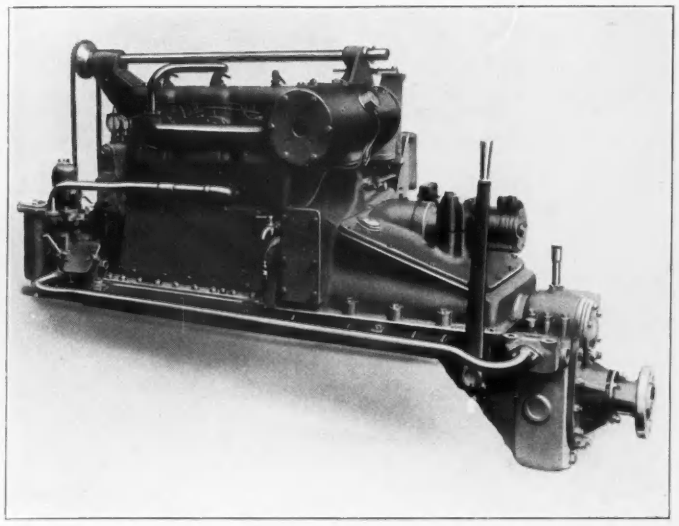
FIG. VII—PORTABLE PLANT—WELDING SUPPLIES

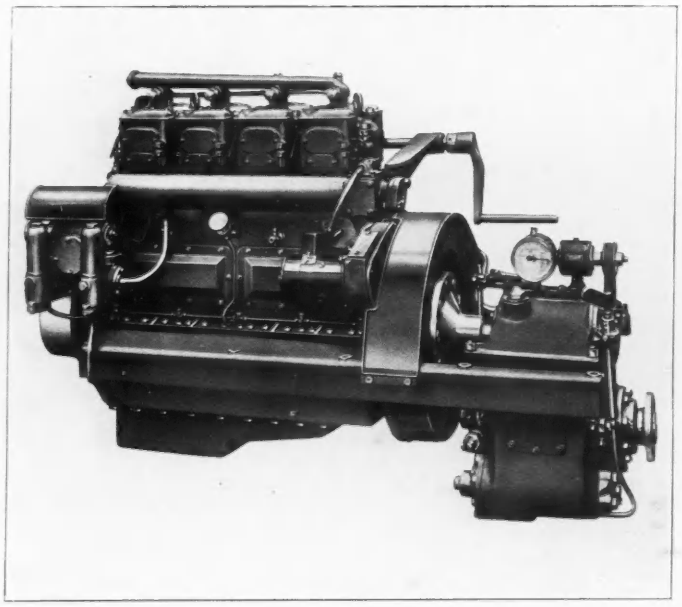
FIG. VIII—PORTABLE A.C. EQUIPMENT—ENGLISH ELECTRIC

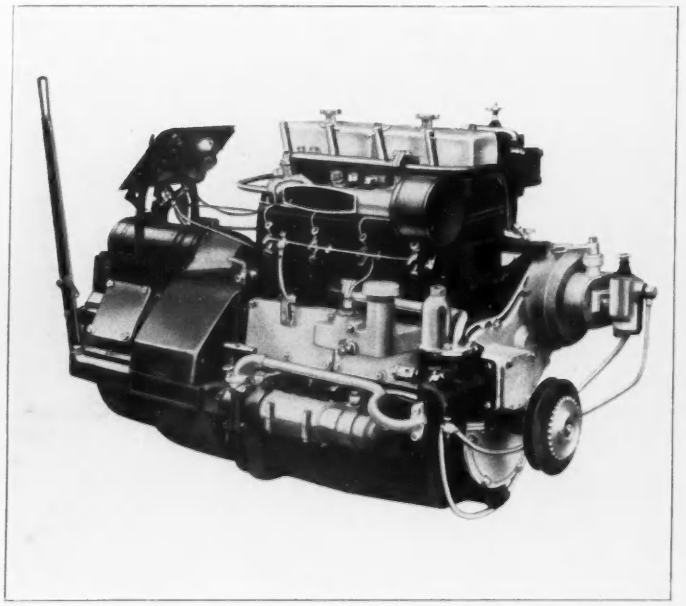
FIG. IX—UNIVERSAL A.C. WELDER—PETBOW

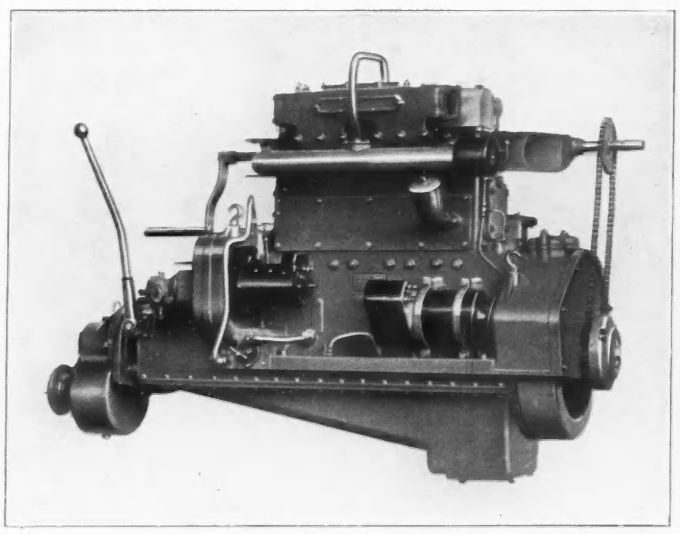
MARINE OIL ENGINES AT THE OLYMPIA EXHIBITION











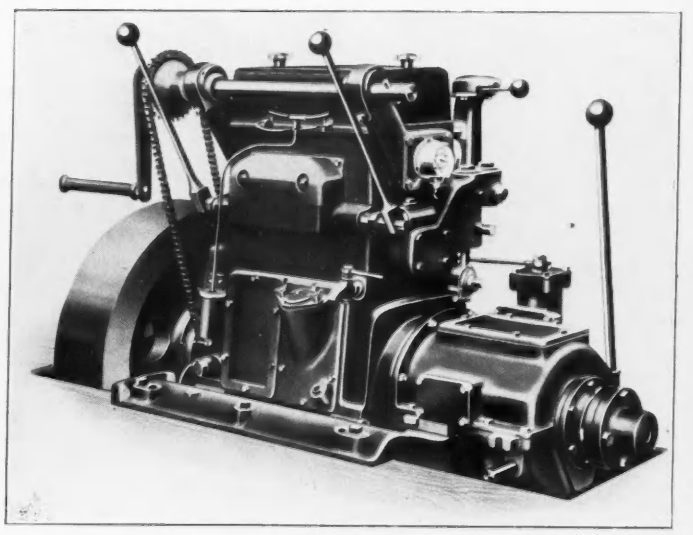


FIG. X—FOUR-CYLINDER 68 B.H.P. ENGINE—NORRIS, HENTY

FIG. XI—THREE-CYLINDER 30 B.H.P. ENGINE—RUSTON

FIG. XII—FOUR-CYLINDER 37 B.H.P. ENGINE—NATIONAL

FIG. XIII—FOUR-CYLINDER 30 B.H.P. ENGINE—MCLAREN

FIG. XIV—FOUR-CYLINDER 47 B.H.P. ENGINE—THORNYCROFT

FIG. XV—TWO-CYLINDER 18 B.H.P. ENGINE—LISTER

A Seven-Day Journal.

Suez Canal Traffic.

ACCORDING to the current bulletin of the Suez Canal Company, the tonnage passed through the Canal during the month of July, 1937, reached the maximum figure ever recorded for that month. The total amounted to 3,036,000 tons, an increase of 14·7 per cent. over July, 1936. The figure of 21,582,641 tons passing through the Canal during the first seven months of the year was also an improvement on the 18,686,121 tons passed during the first seven months of 1936. The principal increase was in north-bound traffic. Cargoes and merchant shipping amounted to 2,514,000 net registered tons, against 2,062,000 net registered tons for the corresponding period in 1936, and merchandise traffic amounted to 2,929,000 tons, an increase of 36·2 per cent. over July, 1936. During the first ten days of the present month 157 vessels passed through the Canal, as compared with 167 during a similar period in September, 1936. From the beginning of the present year to September 10th last, the total number of vessels which passed through the Canal was 4646, while during the same period of 1936 the number of vessels was 4056.

Lancashire Central Coal Selling Scheme.

THE Lancashire Associated Collieries, an organisation which conducts the central selling of coal in Lancashire and Cheshire, recently held its second annual meeting. The chairman, Sir Robert Burrows, said that the gross surplus on the profit and loss account was £473,825, and allowing for depreciation and an amount written off from the preliminary expenses, the remaining profit was £432,042, or 8·09d. a ton on the sales tonnage. On the year's annual supply basic tonnage, this was a profit of 8·86d. a ton. In addition to the profits there had been paid by way of increased purchase prices £612,942, which, in judging the Lancashire Associated Collieries' results, required to be added to the profit, making a total of £1,044,984. This represented 1s. 9·43d. a ton on the basic supply tonnage, which was more than double the total sum for last year calculated on the same basis. Sir Robert said that by far the greater proportion of this total had been paid out to mine workers in additional wages and that the executive board did not feel that the maximum results from central selling had yet been achieved. The profit represented, on actual sales 1s. 7·57d. a ton, but on the output only 1s. 4·79d. a ton, and it is on this latter tonnage that wages were paid. Discussing wages, Sir Robert pointed out that from January, 1936, Lancashire miners received an increase of 1s. a shift and from July of that year a further 2½ per cent. addition had been made to their gross wages. In July, 1937, this was increased to 8·66 per cent. and from August a 5 per cent. increase on the gross wages had been paid in addition to the 1s. a shift, although the wages ascertainments did not justify the increase. The prices of pit timber are rapidly increasing, and Sir Robert stated that this and other increased cost could only be met in part by economies in colliery working.

Presentation to Dr. Hele-Shaw.

AT the conclusion of the inaugural luncheon of the Engineering and Marine Exhibition on Thursday, September 16th, a presentation was made by the President, Engineer Vice-Admiral Sir Harold Brown, on behalf of the management of the Exhibition to Dr. Hele-Shaw on his retirement from the chairmanship of the Committee of Experts which he had occupied for fourteen years. The presentation took the form of a silver loving cup and a wireless gramophone. In acknowledging it, Dr. Hele-Shaw referred to the confidence which the engineering industry reposed in Mr. Bridges, and mentioned particularly the trying conditions which occurred in 1914 when, with all arrangements made for the Exhibition of that year and with the money already collected from exhibitors, the Great War opened. The exhibitors had such trust in the organiser that they left their money in the hands of trustees, of whom the late Sir Archibald Denny was one, to hold until such time as the series of Exhibition could be reopened. He concluded a short and admirable speech by calling for the toast of "Mr. F. W. Bridges." There was literally a response by acclamation to that call and Mr. Bridges, obviously much moved by it, spoke without preparation, of the rise and progress of the Exhibitions and the very great help that Dr. Hele-Shaw had given for thirty years, not only in an advisory capacity in early years, but later as Chairman of the Committee of Experts and as an unsurpassable host at the numerous social gatherings arranged in connection with the Exhibition. He mentioned that in the early days a good deal of work fell upon the Expert Committees, but the organisation had now been brought to such a pitch of perfection that the work went on automatically and the management very rarely found it necessary to call those Committees. We may add that at this luncheon Sir Richard Redmayne proposed the toast "Success to the Exhibition, which was acknowledged by Lord Dudley Gordon, Mr. A. C. Turner, President of the Foundry Trades Equipment and Supplies Association, Ltd., and by Mr. C. F. Bainbridge, Chairman of the Welding Exhibition Committee. "The President" was proposed in a thoughtful little speech by Mr. William Reavell, and Sir Harold Brown made an appropriate and short response.

Older Men in Employment.

AT a recent meeting of the Greater Birmingham Employment Committee, Lord Austin, who is the Chairman, made an appeal to employers to consider the claims of older men when jobs were available. Lord Austin said that he was, at the age of seventy-one, still capable of doing a day's work, and that others were doubtless in like case. He pointed out that when the older applicant for work applied at the factory gate he was usually interviewed by a member of the staff appointed for that work, who had difficulty in assessing the experience of the applicant, and suggested that some guide as to the experience might be provided by the labour exchanges. Mr. Paul H. Brind, Secretary to the Committee, remarked that the exchanges had complete records of all applicants. Mr. David Thirsk, the Vice-Chairman, replied that although complete records existed they lacked the sympathetic "human" information. The Committee might benefit by the experience gained by the King's Roll Committee, which had succeeded in placing in employment men who were physically disabled. The Committee had interviewed the men personally and found out their capacities, regardless of their previous employment. A member of the Committee pointed out the absurdity of advertisements sometimes seen which asked for skilled men aged 20 to 26. In support of his contention that men of a certain age could be employed satisfactorily, Lord Austin quoted the unemployment figures for Greater Birmingham. He stated that some 50 per cent. of the registered unemployed were over 45. Of these, 50 per cent. had been totally unemployed for less than three months, and many in the 55–60 age group had been able to secure and perform work recently.

Magnesium and Its Alloys.

FOR the past five years an investigation has been in progress at the National Physical Laboratory under the supervision of the Superintendent of the Metallurgy Department, on magnesium and its alloys. The results of this investigation, together with a summary of all the available information on magnesium, its alloys, its origin, and methods of obtaining it, have been collected in a publication entitled "Magnesium and its Alloys," just published by His Majesty's Stationery Office, price 2s. 6d. The authors, Dr. J. L. Haughton, D.Sc., F. Inst. P., and Mr. W. E. Prytherch, M.Sc., have been at much pains, not merely to provide the fullest possible information from the metallurgical point of view, but also to deal fully with the characteristics of the various alloys likely to interest the engineer, for example, the resistances to corrosion by water, by sea water, and by various fuels, particularly aircraft fuels, containing lead tetra-ethyl. The book itself is illustrated with diagrams and with engravings from photographs of actual magnesium alloy castings and pressings, to accompany the practical and instructive chapter devoted to the working and heat treatment of magnesium alloys.

Land Drainage Report.

THE "Report of Operations and Proceedings under the Land Drainage Act, 1930," has recently been issued through H.M. Stationery Office by the Ministry of Agriculture. The history of land drainage from 1427 to 1927 is dealt with in the introduction to the Report. As a result of the inadequacy of the machine which existed for the prevention of flooding, a Royal Commission was appointed in 1927. The Commission came to the conclusion that "there should be one authority in charge of the catchment area of each of the main rivers of the country, with exclusive control over the main channel and with adequate financial resources." The Act was passed in 1930 on this basis. At present there are forty-six areas with catchment Boards in England and Wales, replacing some 361 former drainage authorities and 156 sanctions for loans totalling £3,559,487 have been issued. The Report states with reference to the Rye Bay sea defence scheme of the Rother and Jury's Gut Catchment Board, that, following an actual breach in the existing defences in November, 1930, an emergency scheme was approved, which has now been completed at a cost of £177,000, whereby the coastline has been consolidated over a length of 3¾ miles. Another urgent scheme completed is on the north Norfolk rivers between Hunstanton and Wolferton, where beach erosion has been temporarily arrested. A scheme of improvement of the River Medway Catchment Board is estimated to cost £450,200, and to take from ten to fifteen years to complete. This scheme provides for the improvement of some 60 miles of tidal embankments and other works. The River Nene Catchment Board's scheme is estimated to cost £748,490, and provides for land drainage and improvements in water supply and navigation from Northampton to the outfall of the river Nene into the Wash.

The Model Engineer Exhibition.

THE nineteenth *Model Engineer* Exhibition which was formally opened at the Royal Horticultural Hall, Westminster by Sir Nigel Gresley on Thursday of last week, September 16th, belies its name in several respects. It is not devoted entirely to the display of engineering models. Almost if not quite half the models shown are of ships, with the "Queen Mary" a favourite and the "Golden Hind" and other ancient vessels a good second. Nor is it devoted entirely to the display of models. More than half the crowded floor space of the hall is occupied by the stands of a number of well-known tool makers and merchants who specialise in the supply of the equipment and material used by model makers and amateur mechanics. Nor again, as the uninitiated might infer from the title, are the exhibitors of the models principally schoolboys and other youths. They include among their number the chief engineer of a big firm at Ipswich who contributes an electric motor measuring ¼in. cube—and who incidentally has the courage to display alongside the finished model the parts which he spoilt in making it—the Town Clerk of Dorchester, the Medical Officer of Health for Northampton, a blacksmith, a plumber, an ex-seaman and many others who between them must embrace almost every profession and trade in the country. The majority of the model exhibitors are, we were told, middle-aged people. There are many more between the ages of fifty and seventy than between ten and twenty. We are glad to learn that in making the awards in the various classes Mr. Marshall and his co-adjudicators take into account not only the perfection of the workmanship but the circumstances in which the model was made. The opulent model maker who can afford to buy expensive tools and equipment is properly penalised if he competes with an exhibitor who has used a knife as his principal tool. Encouragement is rightly given to those who seek not only to make their models, but to produce the tools which they require. To the staid full-grown engineer the Exhibition is refreshing. By some it will be found a delightful counterpart to its big brother at Olympia.

Coal Production in Great Britain.

THE Government has recently published a Blue Book which incorporates the sixteenth annual report of the Secretary of Mines and the twenty-ninth annual report of H.M. Chief Inspector of Mines for last year. According to the former report, the world production of coal in 1936 was twenty-six million tons in excess of that in 1913, and the production in this country had fallen by sixty million tons. The main cause of this decrease is attributed to loss of export trade as a result of the increased consumption of native coal, increased use of oil for bunker purposes, increased efficiency in burning appliances, and intensified foreign competition. Notwithstanding the decline in exports, the output of this country was six million tons more than in 1935. In 1933 the quantity of coal available for consumption for all purposes in Great Britain amounted to 148,500,000 tons, but in 1936 it totalled nearly 176 million tons. As compared with 1935, the consumption of coal and coke in the iron and steel trades showed an increase equivalent to 2,750,000 tons of coal. There was a rise in coastwise cargo shipments, which totalled 23,750,000 tons. Including mine consumption and miners' coal, the average net selling value at the mine of all saleable coal raised was 14s. 0·25d. a ton, as compared with 13s. a ton in 1935. The proportion of the total coal output cut by machines during the year was 55 per cent. and 48 per cent. was conveyed mechanically. Coal cutting machines were in use at 864 mines and mechanical conveyors and loaders at 637. There were 2080 mines at work during 1936 under the Coal Mines Act, as compared with 2075 the previous year. Dealing with other mining and quarrying industries, the report states that 12,701,000 tons of iron ore and ironstone were produced in 1936, and this, with the exception of 1929, is the highest figure since the war. It is shown in the report for H.M. Inspector of Mines that on the average 172,154 persons were employed on the surface and 605,720 underground at the mines under the Coal Mines Act. During the year 790 people were killed, 3117 persons were seriously and 135,968 persons were slightly injured. The fatality figure is the lowest on record for a full year.

Super Tension Cables.

No. VIII.

(*Continued from page 302, September 17th.*)

THE gas cushion cable developed by Henley's Telegraph Works Company, Ltd., and at present undergoing a long-time test in Holland is another super-tension cable designed to overcome ionisation troubles. It is an armoured cable, which may be

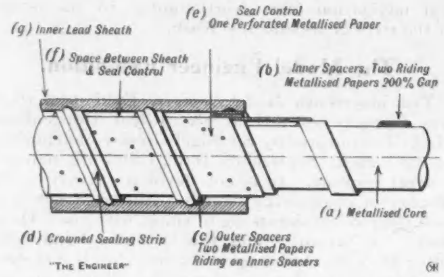

(e) Seal Control
One Perforated Metallised Paper
(g) Inner Lead Sheath
(f) Space Between Sheath & Seal Control
(b) Inner Spacers, Two Riding Metallised Papers 200% Gap
(a) Metallised Core
(d) Crowned Sealing Strip
(c) Outer Spacers Two Metallised Papers Riding on Inner Spacers
"THE ENGINEER"
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FIG. 68—DETAILS OF GAS CUSHION CABLE

laid directly in the ground, and it does not call for exceptional accessories. The advantages of the simple form of paper dielectric impregnated after application to the conductor are retained. Between the dielectric and lead sheath is a screened space,

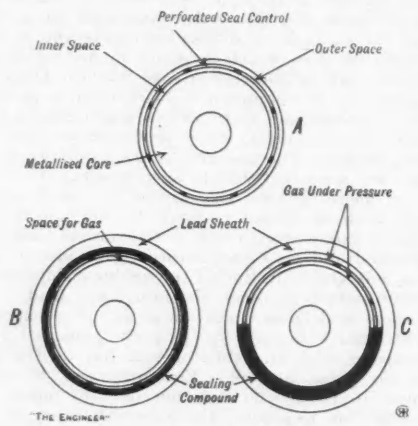


FIG. 69—PROCESS OF CHARGING AND SEALING GAS CUSHION SPACE

which provides accommodation for the storage of inert gas at all points along the cable. Transmission of pressure through the sheath from the outside is thus avoided. The cable is a complete unit with its own armouring, requiring no external pipe protection.

FIG. 70—GAS CUSHION CABLE

Storage of the inert gas is maintained in a series of gas cushions in a sub-divided and screened space along the cable length. These gas cushions serve the two-fold purpose of applying pressure to the dielectric to prevent ionisation and of permitting local expansion and contraction of the compound during fluctuating loads. Each inch of the cable provides the accommodation for the expansion of compound in that inch, and during cooling on reducing load, the compound need only travel radially into the dielectric. As the separate gas cushions are isolated from one another by barriers, a cable may be cut for jointing without losing gas from more than quite a short length, while if the cable is accidentally damaged the restriction of flow of gas along the length makes it possible to effect a local repair without difficulty.

In principle the gas cushion cable differs but little from the normal solid type of impregnated cable in which expansion of the compound during heating takes place into spaces left fortuitously during manufacture or formed by the expansion of the sheath. In the gas cushion cable, however, every inch of the cable has its expansion space and is provided with an internal pressure for raising the dielectric strength. Gas cushions are formed by spiral spacers wound over the screened core. The spacers are made up of layers of metallised paper, retained in position by a narrow metal strip coated with a film of low melting point alloy before application to the cable, so that it may subsequently adhere to the lead sheath and provide a perfect barrier to prevent escape of gas.

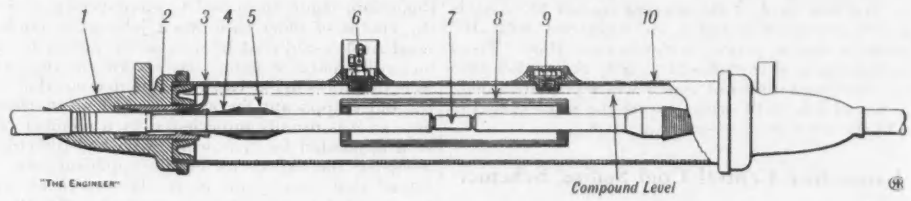
In Fig. 68, *a* is the core insulated and impregnated in the usual way, *b* the inner half of the spiral spacer consisting of piled paper strips, *c* the outer half of the spiral spacer, *d* the metal strip binding down the spacer on the core and subsequently soldering itself to the lead sheath, and *e* the seal control, consisting of a wide strip of perforated paper built up halfway through the gas cushion space to facilitate sealing the individual turns of this space. To secure the full gas cushion principle it is not only necessary to ensure that there is no passage of gas longitudinally past the barriers *b* and *c*, but also that there must be no direct path around the spiral space.

Compliance with this last condition is, of course, opposed to the conditions required for charging the cable with gas, but difficulties in this direction have been removed. When the spiral spaces, control seal, and metal binding strip have been applied to the previously impregnated core (Fig. 69A), the cable is lead sheathed and as it passes into the lead press, the space between the seal control and lead sheath becomes filled with sealing compound. Owing to the viscosity of the compound and the smallness of the holes in the seal control paper, the compound remains almost entirely in the outer half of the gas cushion space, as shown in Fig. 69B, so that subsequent to the lead covering operation, while the outer half of the gas cushion space is entirely blocked with compound, the inner half still remains open for the charging gas from the end of the cable length.

After the application of the lead covering the cable is reinforced with non-magnetic tapes and gas at a pressure of about 12 atmospheres is then admitted to the inner half of the gas cushion space and the ends of the length are sealed. At this stage the cable is in the condition shown in Fig. 69B, where it will be seen that the outer half of the gas cushion space is filled completely with sealing compound and the other half with gas under pressure. Subsequently the sealing compound gravitates through the holes in the seal control, changing in position from that shown in Fig. 69B to that in Fig. 69C. As the compound moves from the complete outer half of the spiral into the low part of both halves, the gas travels to the upper part of the cable and the compound forms a complete seal in each turn of the spiral space. Hence after this sealing operation the individual gas cushions consist of separate saddle-shaped spaces, each approximately half the circumference of the cable and sealed at both sides by a packing of paper held down by the alloy coated strip, which in turn is sealed to the lead and at the two lower ends by the sealing compound standing in the lower half of the groove. To discourage the escape of gas pressure longitudinally the conductor is of special construction. Instead of employing round wires in the strand, shaped wires are assembled to form a voidless conductor, which not only prevents the escape of gas longitudinally, but also reduces the amount of compound to be accommodated in the gas cushion space during the expansion of the compound on heating.

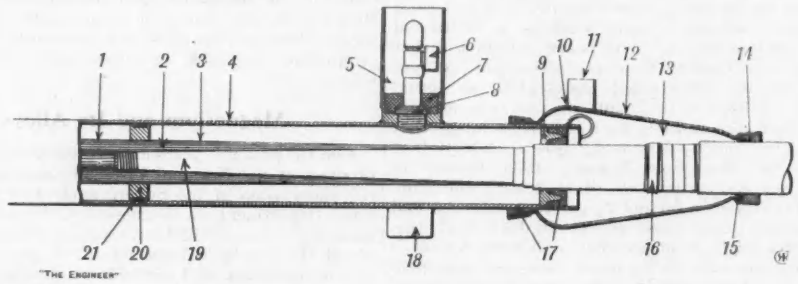
The solid or voidless strand of the cable is to be seen at the top of Fig. 70. Next comes the normal paper-lapped dielectric and the metallised paper screen over which is the spiral construction consisting of the control screen supported above and below by the spacer strip. The outer spacer strip is bound down by the metal strip, which solders itself to the lead sheath when it is applied. A double lead sheath with intermediate metal tape reinforcement with the usual servings over all are also shown.

While the details of construction of the joints and terminals for gas cushion cables depend to some extent on the working voltage, Figs. 71 and 72 show two alternative designs of joint for 66-kV single-core cable, and illustrate the principal features. Apart from the fact that the joint shell is designed to with-



1, cast plumbed union; 2, cable gland; 3, copper pipe; 4, stress cone; 5, reinforcement; 6, valve; 7, cable connectors; 8, insulating sleeve; 9, filling plug; 10, copper shell.

FIG. 71—SECTION THROUGH 66-KV GAS CUSHION CABLE JOINT



1, conductor joint; 2, applied insulation; 3, metallised layer; 4, shell; 5 to 8, gas valve assembly; 9 to 17, components of cast plumbed union; 18, drain plug; 19, tapered core insulation; 20, core support; 21, tape binder.

FIG. 72—SECTION THROUGH 66-KV JOINT WITH PAPER STRIPS LAPPED ON CORE

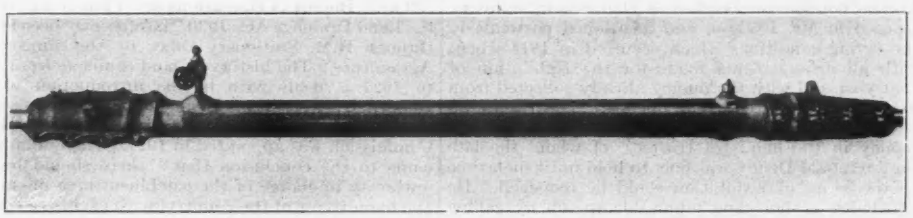


FIG. 73—132-KV STRAIGHT THROUGH GAS CUSHION CABLE JOINT

stand the cable working gas pressure, the construction is very similar to that of normal non-pressure cables. In the first design, Fig. 71, there is a semi-barrier at each end of the joint to restrict the flow of compound, but the pipe 3 permits free passage of the

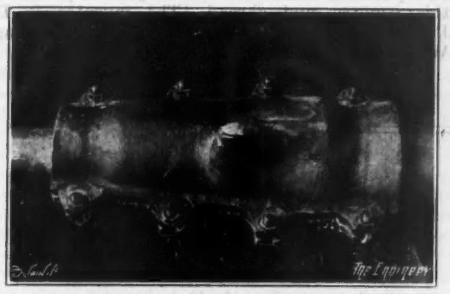


FIG. 74—CAST PLUMBED UNION

gas through the joint. The cable cores are reinforced in the normal way, with the paper cone 5 and stress cone 4. A standard cable connector 7 is sweated to the conductor and the centre of the joint is insulated with the sleeve 8. High-voltage filling compound is

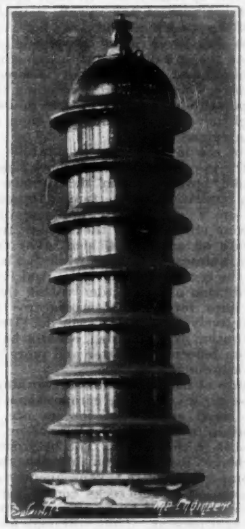


FIG. 75—TERMINAL FOR 66-KV GAS CUSHION CABLE

used within the shell. A valve 6 is provided in one of the filling plug holes, so that after the joint has been constructed, the joint shell and the ends of the cable may be charged with gas under pressure, to compensate for any loss which may have occurred

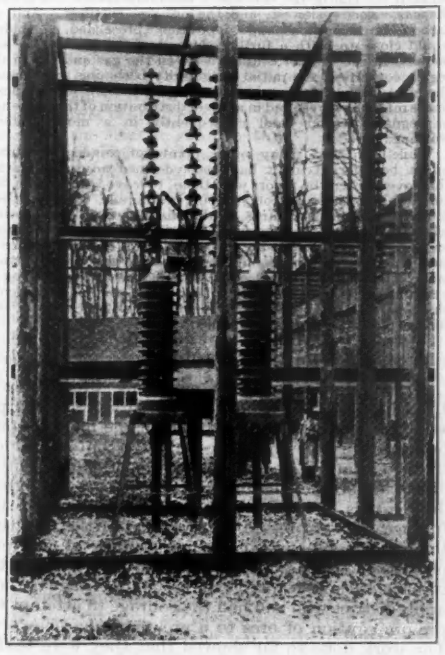


FIG. 76—132-KV TERMINALS FOR GAS CUSHION CABLES

from the first few feet of cable during the jointing operation.

The second design, Fig. 72, is a type in which paper strips are lapped on to the core to replace the insulation previously removed for the purpose of making the conductor joint 1. The paper lapping 2 is carefully applied to the tapered core insulation 19, and a metallised layer 3 is applied overall. The shell is filled with compound and a measured air space is left at the top. To enable the joint to be charged with gas on completion, a valve 6 is provided in one of the filling hole plugs.

In Fig. 73 is shown a complete 132-kV straight-through gas cushion joint on a piece of 132-kV cable.

FIG. 77—OUTER INSULATING TUBE FOR 132-KV TERMINAL

The joint shell is a solid drawn copper tube, of comparatively small diameter and long length, capable of withstanding the full gas pressure. At the ends are special cast plumbed unions, which are necessary for cables of this type. A close view of one of these plumbed unions on this joint is shown in Fig. 74. The mould is fitted to the joint shell and cable, and the ends of the mould are caulked with lead wool. In this type of plumbed union there are no signs of the small blow-holes normally present in hand wipes.

With the exception that the cable end is closed with an insulating bushing, capable of withstanding the gas pressure within the cable, the construction of the terminal does not differ materially from that of the normal terminal used for mass-impregnated cables. The outer porcelain shell is not subjected to gas pressure. A complete terminal for a 66-kV gas cushion cable is shown in Fig. 75, and two 150-kV terminals in Fig. 76, where the cast plumbed unions can be seen immediately under the two sealing ends. The cable with which these joints are associated is at present on a long life test in Holland at the equivalent of 260 kV, three-phase. A view of the outer insulating tube in the double tube gas-tight assembly used for terminating 132-kV cable is shown in Fig. 77. This assembly is housed in a porcelain insulator, as in Fig. 75.

The employment of the gas cushion principle

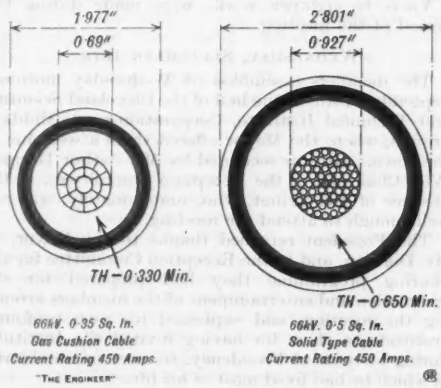


FIG. 78—GAS CUSHION AND SOLID CABLES

enables considerably higher working stresses to be adopted than usual, with a consequent reduction in dielectric thickness and cable section. At working voltages of 33-kV the chief advantage gained from the gas cushion principle is to be found in the reduction in cable weight. Owing to the cost of applying the gas cushion the saving due to reduction in dielectric

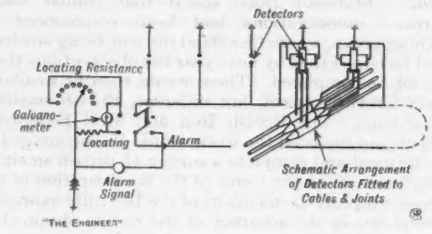


FIG. 79—DIAGRAM OF LEAKAGE PROTECTIVE SYSTEM

is to some extent neutralised, but at the higher voltages of 66 kV and upwards, there is a considerable saving in section, and the cost is said to be appreciably reduced. An example of this saving is indicated diagrammatically in Fig. 78. On the right is shown a 0·5 square inch, single-core, 66-kV solid cable, suitable for transmitting 450 amperes, and on the left a 0·35 square inch, gas cushion cable, for the same voltage and loading. The solid type of cable on the right is designed for a maximum working temperature of 65 deg. Cent., while the gas cushion cable may safely work at 75 deg. Cent. Needless to say, the saving in section not only makes possible the production of a cheaper cable, but, owing to the reduction in weight, facilitates installation. For working voltages of 132 kV and above, the cross section of a normal cable would have to be so great that it would become impracticable. Special cables, such as those described in these articles, are therefore essential, and the gas cushion cable is claimed to be particularly economical from the standpointof the few accessories required.

During the developmentof the gas cushion cable, special attention was paid to preventing the possibility of a gas leak. Although the cable can be designed and constructed to work perfectly satisfactorily with one lead sheath, it is considered that for important installations a second lead sheath and a system of protection are desirable. The scheme designed for protection consists in screening the

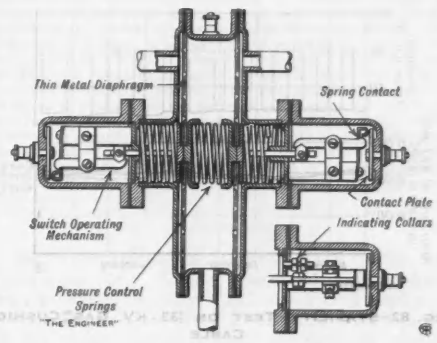


FIG. 80—DETAILS OF LEAKAGE PROTECTIVE SYSTEM

cable with an outer space connected to indicating apparatus which sounds an alarm if the space becomes charged with gas from the cable. The system is arranged so that should the space itself be actually punctured by corrosion or mechanical damages, and thus cease to be effective, an alarm will also give warning.

This is effected by maintaining this space at a normal pressure above or below atmosphere. The broad principle of the system is shown in Fig. 79. Three chambers (Fig. 80) are connected by tubing to the intersheath space. If a difference of pressure occurs between the three chambers, due, for example, to a leak in one of the inner lead sheaths, deflection of one or both of the diaphragms will occur, and the switch mechanism will be operated. This connects a pilot circuit to earth, an alarm is sounded at the station, and by means of a throw-over switch and locating arrangement the joint section position can be immediately located. To determine the position of the leak the two covers of the indicators are

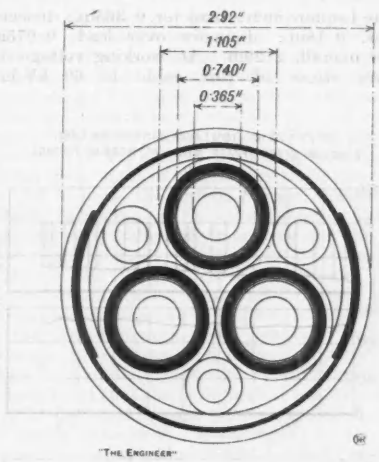


FIG. 81—33-KV GAS CUSHION CABLE

removed and the position of the indicating collars noted. There are six possible combinations in which these collars can be arranged. If, for example, the outer right-hand collar has moved to the right and the other collars have remained unmoved, it is known that the pressure in the right-hand chamber has fallen, thus indicating a leak in the outer sheath of the cable attached to this chamber. To allow for slight changes in pressure due to temperature variations, the indicator springs are adjusted so that they will only operate at pressures above the maximum variation caused by temperature that is likely to occur.

For the following tests the cables were laid in the ground and heated by current in the conductor to the specified temperature twice a week for six months. During the whole time, including both heating and cooling periods, the cables were subjected to a voltage 50 per cent. in excess of that for which they were

designed. Power factor tests were taken on the cold cable before the application of the heating current, and the results plotted against time. Twelve gas cushion cables for voltages up to 150 kV have so far

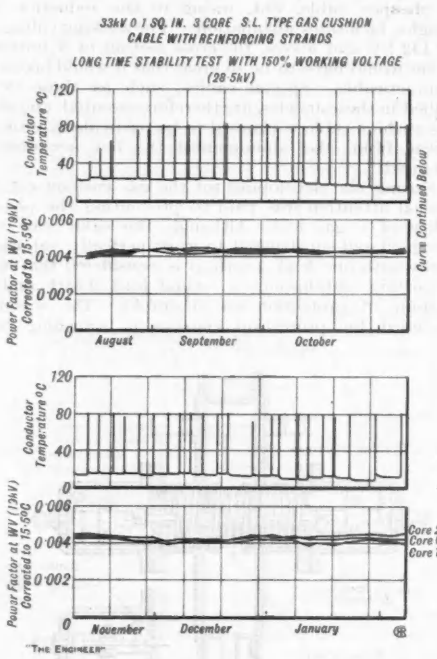


FIG. 82—STABILITY TEST ON 33-KV GAS CUSHION CABLE

been made, and typical examples of tests on cables to work at 33 kV and 66 kV are given above and below.

The construction of the 33-kV cable is shown in Fig. 81. The main dimensions of this cable are:—Con-

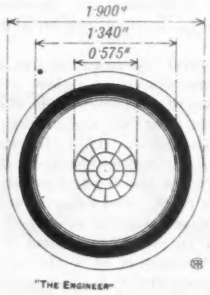


FIG. 83—66-KV GAS CUSHION CABLE

ductor, 0·1 square inch; diameter, 0·365in.; dielectric thickness, 0·18in.; diameter over lead, 0·975in.; diameter overall, 2·29in. At working voltage the maximum stress of this cable is 60 kV/cm.,

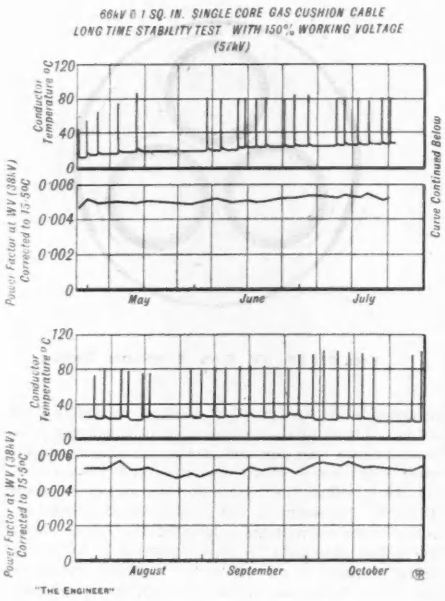


FIG. 84—STABILITY TEST ON 66-KV GAS CUSHION CABLE

and during the test it was subjected to 90 kV/cm. The diagram, Fig. 82, shows the way in which the temperature of the conductor varied during the test, and the power factor measured on the three separate cores. It will be seen that the cable is completely stable under the onerous conditions to which it was subjected during this test.

The main dimensions of the 66-kV cable tested (Fig. 83) are: Conductor, 0·25 square inch; diameter, 0·575in.; dielectric thickness, 0·375in.; diameter over lead, 1·655in.; and diameter overall, 1·9in. At working voltage the maximum stress is 63 kV/cm., and during the test it was working at a stress of 94·5 kV/cm. The results of the stability test on this cable are given in Fig. 84, where it will be seen that after 35 cycles up to 80 deg. Cent., the temperature was raised to 100 deg. Cent. for 9 cycles without any appreciable effect on the power factor. The gas cushion itself and the method employed for producing cast plumbed unions are the subject of patents in this country and abroad. The inventor is Dr. P. Dunsheath, chief engineer to Henley's Telegraph Works Company, Ltd.

(To be continued.)

The Iron and Steel Institute.

No. I.

FOR the fourth time in its history, the Iron and Steel Institute held its autumn meeting last week in Middlesbrough, the last such meeting having been held in the town twenty-nine years ago.

The President this year is Mr. Alfred Hutchinson (director of the Skinningrove Iron Company, Ltd.).

A Reception Committee representative of the civic, industrial, and educational interests of the district, under the chairmanship of Mr. Benjamin Talbot (a Past-President of the Institute, deputy chairman and managing director of the South Durham Steel and Iron Company, Ltd., and Cargo Fleet Iron Company, Ltd., and the inventor of the Talbot continuous process of steel manufacture), arranged for the members and their ladies a very full programme of entertainment, technical discussions, and visits to works.

The opening function was a reception by the Mayor and Mayoress of Middlesbrough (Councillor and Mrs. G. Carter), on Tuesday evening, September 14th, at the Constantine Technical College. This College is due to the generosity of the late Mr. Joseph Constantine and family, who provided £80,000 towards the cost of the building, a further £26,000 being subscribed by local firms and individuals. Other social functions included luncheon at the Town Hall, Middlesbrough, on Wednesday, September 15th, by invitation of the Mayor of Middlesbrough and the Reception Committee; an evening party at Mount Grace Priory, by invitation of Sir Maurice Bell, (Hon. Vice-President); a ball and supper at the Town Hall, on Thursday, September 16th, by invitation of the Reception Committee; and a garden party on Friday, September 17th, at Solberge Hall, by invitation of Mr. Benjamin Talbot.

Visits to eighteen works were made during the period of the meeting.

WEDNESDAY, SEPTEMBER 15TH.

The members assembled on Wednesday morning, September 15th, in the hall of the Cleveland Scientific and Technical Institute, Corporation-road, Middlesbrough, where the Mayor offered them a welcome to the town. He was seconded by Mr. Arthur Dorman (Vice-Chairman of the Reception Committee), in the absence of Mr. Talbot, who, unfortunately, was not well enough to attend the meeting.

The President returned thanks to the Mayor, to Mr. Dorman, and to the Reception Committee for the alluring programme they had prepared for the instruction and entertainment of the members attending the meeting, and expressed his own profound gratitude to them for having invited the Institute, during his year of Presidency, to meet in the district in which he had lived most of his life.

REPORTS UPON BLAST-FURNACE FIELD TESTS.

Professor W. A. Bone, F.R.S., presented the report of the Blast-furnace Reactions Research Sub-Committee (of which he is Chairman), which was made to the Blast-furnace Committee of the Iron and Steel Industrial Research Council. The report, which fills ninety-eight pages of the "Proceedings," deals with an "Investigation of a Blast-furnace Smelting Principally Lincolnshire Ores at the Frodingham Works of the Appleby-Frodingham Steel Company, Ltd." Professor Bone added that similar blast-furnace investigations had been commenced at Skinningrove, where Cleveland ore was being smelted, and he hoped that by next year the observations there would be completed. There would then be available data for two typical, but different, British smelting conditions. The British Iron and Steel Federation which had financed the work, would be encouraged to go forward and complete a survey of British smelting conditions if, as the result of the consideration of the present report, the members of the Institute expressed confidence in the accuracy of the results obtained.

During the investigation improved methods have been devised and successfully established for the determination of temperatures at short intervals across selected horizontal planes in a blast-furnace, as well as for the taking of "gas" and "solid" samples almost simultaneously with each temperature measurement. And it may be claimed that such simultaneous samplings and measurements have not been so completely effected in any previous blast-furnace investigation.

In order to arrive at a true general perception of the conditions prevailing throughout the stack as a whole, it has been necessary to deduce proper statistical averages for the numerous temperature measurements and gas compositions at each sampling point.

Such "average" results, while generally valid for the particular furnace and smelting conditions concerned, cannot be claimed to be necessarily applicable to other furnaces operating upon other ores and fuel, under widely different conditions as to rates of driving and distribution of the burden within the stack. Other furnaces and smelting conditions will have to be similarly investigated before any more general conclusions can be drawn.

Perhaps the most striking and revealing feature of the results is the fact that the temperature and physico-chemical conditions were found to be far from uniform across any one of the selected horizontal planes in the furnace, thus proving that in this particular case at all events, any conception of "uniformity" in the conditions across a given horizontal plane must be ruled out as fallacious. In fact, apart from a slight fall in temperature just at the inwall, doubtless due to the cooling effect of the stack wall and its coolers, the temperatures observed across any given plane were usually higher at the centre and near the inwall than at intermediate points, and reached a minimum at points usually nearer to the inwall than to the centre. Moreover, in descending the furnace such minimum temperature points appeared to move away from the centre, although never approaching less than about 4ft. from the inwall at any given plane.

The results of the investigation as a whole may be said to have stressed the importance of the proper sizing and distribution of the solid burden within the furnace. The material comprising the burden of this particular furnace varied in size from lumps of ore weighing 60 lb., and sometimes more, down to dust, and were charged into the furnace from a bell, 13ft. in diameter, with an angle of 45 deg. The fines and smaller pieces fell from it almost vertically, while the large pieces rolled down towards the centre and the wall. And it is principally to such size distribution of the burden within the stack that the characteristic lines for equal temperatures and equal CO_2 contents respectively may be ascribed. Doubtless a more even size distribution of the burden, could it have been ensured, would have been reflected in better and more uniform working conditions throughout the furnace.

A further cause of irregularity in the working of this furnace may perhaps be variations in the compositions of the ores used, apart from a small amount of foreign ore, not only from stratum to stratum in the beds, but also along, and away from, the working faces in the mines. The heterogeneity comprised not only the chemical composition, but also the size and hardness of the component strata; consequently a change in the chemical composition of the rocks composing the ores would most likely be accompanied by an alteration in the proportions of the various sizes present. Thus, although a chemical analysis used in burdening the furnace may be used also to determine fairly accurately the ultimate slag composition, it gives no information concerning the changes which will occur in the conditions within the stack when a changeover or alteration is made, because it does not take into account the effect of the physical properties, size and distribution of the component elements throughout the different sizes.

Another factor connected with size distribution is the influence which it might be expected to exert upon carbon deposition in the upper region of the furnace. In the case of the particular furnace under investigation, it is clear that the most favourable region for carbon deposition would be directly beneath the rim of the bell where the temperature was lowest, the gas velocity slowest, and the ore size smallest. And, as carbon impregnation and deposition proceeded, "voids" would close up, with a further slowing of the gas stream and increase in the time of contact between the gas and ore in the region concerned, the initial irregularity becoming accentuated thereby. Here, again, a better sizing of the ore within closer limits might have resulted in a better distribution of the deposited impregnated carbon and consequently in a more uniform working.

While doubtless many other points of minor importance might be referred to, it has been deemed advisable, rather than overburden the report with them, to leave readers who find time and opportunity for studying its details, to bring them forward during the course of the discussion at the meeting when this report is presented. It is hoped, however, that enough has been said to convince readers of the importance of such an investigation upon blast-furnaces, and more particularly of extending it to typical British furnaces operating in other localities upon ores other than those smelted in Lincolnshire, so that ultimately it may embrace all the varying conditions of British smelting practice.

DISCUSSION.

Mr. W. J. Brooke (joint managing director, John Lysaght, Ltd., Normanby Park Works, Scunthorpe) said that the peculiar variatious in the lines of equal temperature and lines of equal CO_2 content respectively within the stack indicated that the distribution of the material in the furnace was causing very great differentials across the horizontal sections of the furnace. He expressed appreciation of the fact that the report emphasised the importance of the pre-preparation of the ores before they were put into the furnace, because it was of enormous advantage to those in his district who had had the courage to attempt the pre-preparation of ores to a greater or lesser extent. The work done so far showed that they were taking a step in the right direction. The report confirmed to a great extent many of the opinions formed as the result of the investigations started by Sir Lowthian Bell many years ago, and indicated that those investigations were on the right lines.

Mr. R. A. Hacking (a member of the Sub-Committee) said that the principal point to be derived from the isothermal and iso-CO_2 diagrams was that there were enormous gradients of temperature and CO_2 contents along the horizontal plane in the furnace,

The general form of the gradients was in a very general sort of way similar to that of the Holt and Illinois furnaces investigated by Kinney and his collaborators for the U.S.A. Bureau of Mines. When one reflected on the dissimilarities of the three units in regard to dimensions, lines, the character of the raw materials, the burden, fuel ratio, &c., that general conformity—to what was undoubtedly an unsatisfactory state of affairs from the standpoint of furnace efficiency alone—might be rather surprising. For instance, the Frodingham furnace used lumps of 60 lb. or more in weight; the Illinois furnace was using ores of probably 60 per cent. fines, 30 per cent. rubble, and 10 per cent. lump up to 3in. or 4in. It was necessary therefore to look for a common factor, and he suggested that the one common factor was the method of introducing the raw materials into the shaft and the general proportioning of the bell to the diameter of the throat. Whilst the crushing and grading of the ingoing solid material (ore, fuel, and flux) could effect substantial improvements, his contention was that so long as the conventional bell and hopper were employed, the general form of the diagrams would remain substantially the same, barring the road to technical progress. It was perhaps as well for the industry that technical attainment did not invariably spell economic progress, and so long as the blast-furnace possessed—as in the majority of cases—the subsidiary (and erstwhile primary) function of a gas producer, the urge to utilise to the full the reducing powers of the gases passing up the shaft was far from sufficient to warrant radical engineering changes of the nature indicated. Whilst the blast-furnace had reigned supreme in its own particular field for several centuries, we must not regard it as the be-all and end-all of the reduction of iron ores.

Although he is a member of the Sub-Committee responsible for the report, Mr. Hacking suggested that there should be qualification of a statement (contained in the summary) to the effect that usually along any horizontal plane the degree of ore reduction was greater near the centre or the inwall than at intermediate points between them. Undoubtedly, he said, that was true in regard to the samples withdrawn from the furnace by means of the solid sampling tube, and the solid sampling tube and the technique employed in getting it in and out of the furnace were by far the best that had been employed by anybody to date. At the same time, he could not agree that the sampling tube took from the furnace an average sample. The circumstance that the degree of ore reduction appeared to be greater in the vertical or semi-vertical zones, where there was a concentration of lump ore, proved that the sampling tube selected the fine material which was detached from the ore lumps and completely ignored the inside of the lumps. If one could take a foot-cube from the three positions (annular ring, intermediate, and centre), he would expect the reverse to be true.

Mr. E. C. Evans (head of research department, British Iron and Steel Federation, and a member of the Sub-Committee) described the research dealt with in the report as a remarkable example of works research which was of both scientific and practical interest. Commenting on the correlation between the isothermal lines, the lines of CO_2 in the furnace, and the contour at the stack line, and, consequently, the importance of bell and throat design on furnace operation, he urged that the work might with advantage be carried further to an exploration of the hearth zone in addition to the zones of rather lower temperature, bearing in mind the tremendous importance of the hearth zone in the ultimate efficiency of operation of the blast-furnace. The volume of air at each individual tuyere might be determined, for example; it should not be difficult to determine whether the air volume was uniform throughout the hearth and the furnace.

Mr. T. Hoskison (blast-furnace manager, Round Oak Steel Works, Ltd., Brierley Hill, Staffs, and a member of the Sub-Committee), said the results of the work confirmed the theory which had for long been held by blast-furnacemen, that successful blast-furnace operation was the result of an average of a constantly varying number of reactions throughout the furnace. Mr. Hacking had drawn the only valid conclusion which could be drawn from the report, that so long as we were blessed with bell charging mechanism we must put up with the heterogeneity which had been disclosed by the research. Mr. Hoskison was confirmed in that opinion by his experience in operating an open-top blast-furnace—which might be considered an anachronism nowadays. One could watch the burden descending in such a furnace and observe it constantly. Provided that such furnaces were kept completely full and there was no drop of the material, therefore, from the furnace barrow to the top of the burden, sizing of the burden did not occur; under such conditions the furnaces worked uniformly and with very little trouble. On the other hand, he had deliberately allowed the top of the burden to descend 8ft. or 10ft. below the furnace top and had observed the material over many hours; under those conditions a distinct sizing occurred, followed by considerable irregularity in the working of the furnace. Therefore, he considered that until we obtained some other charging method than the bell and cone, all furnaces would be subject to heterogeneity, and that, however complete the preparation of the ores, there would still be size separation of the burden.

With regard to the graphs showing the lines of equal temperature and equal CO_2 within the stack, he was not in agreement with the remarks of previous speakers, who might have been led away by the beautiful symmetry of the lines; those lines did not represent what happened in the blast-furnace. They were based upon a series of spot determinations taken over a very considerable period, and at any moment following one at which a determination was made an entirely different result might have been obtained. As an average they might be valid for one-half of the furnace, but he was quite sure that they were not valid for the second half. A plan of the furnace, given in the report, indicated that the experiments were made upon two adjacent vertical lines on the furnace shaft. On the opposite side from that position there were two slag notches, a tapping hole, and, at the top of the shaft, two gas outlets, and the half of a furnace in which those were situated always worked more rapidly than the other half.

An interesting conclusion which might be drawn from the solid samples (and he regretted that they were not greater in number) was that the same degree of reduction could be obtained for a depth of 15–20ft. in the furnace, indicating that the height of the furnace could be reduced. He suggested that if we could evolve some different charging method which would eliminate all size separation in the furnace we should be able to reduce the size of furnaces at least by half, for a given output, so that very considerable economy in coke and cheaper working would be effected and far less trouble would be experienced.

The report, he added, should be regarded as epoch-making. It represented the most thorough and complete investigation on the subject to date, and the Federation would be failing the industry if it did not carry the work forward by investigating the reactions in the blast-furnaces in every iron-producing district of the country. At any rate, the investigation should be extended to an estimate of the amount of blast entering the furnace throughout the periphery of the tuyere, for that was a far more important factor in distribution than was generally appreciated.

Sir William Larke (director, British Iron and Steel Federation), congratulated Professor Bone, not only on the results of the work presented, but also upon his recovery from a very serious operation, and expressed the hope that he would long be spared to exercise his experimental gifts in the interests of the industry. Sir William added that he did not believe there was anyone in the industry who would cavil at the expenditure of money on research in the quest of knowledge for its own sake; but if there were such, the report was an outstanding example of the value of that quest. Some ten years ago Professor Bone had undertaken laboratory investigations into the reactions in the blast-furnace, in order to bring up to date the wonderful work of Sir Lowthian Bell; as a result of that laboratory work (which at that date might have been said to be a quest for knowledge for its own sake) he produced reports which had resulted in the field investigations. The present report opened out a wide horizon of great potential increase in the efficiency of blast-furnace operation and increase of fuel economy, and he appealed to all responsible for the management and operation of blast-furnaces to give the report detailed consideration and communicate their views to the Federation. As to the suggested continuation of the survey throughout the iron-making districts of the kingdom, he said the Federation endeavoured to carry out the wishes of the industry, but the industry must make it possible for the Federation to do what it believed to be essential.

Further written contributions to the discussion were invited; the Sub-Committee will reply in writing.

Mr. F. W. Harbord then presented a paper on "The Thomas-Gilchrist Basic Process, 1879–1937," of which the official summary runs as follows:—

THE THOMAS-GILCHRIST BASIC PROCESS, 1879–1937.

The author gives a short account of the early life and training of Sidney Gilchrist Thomas and of the development of the Thomas-Gilchrist process from the early experiments carried out by Percy Gilchrist and himself in the 6 lb. converter to the present-day production of 90,000,000 tons of basic steel per annum.

After describing the experiments at Blaenavon, and the assistance given by the late Mr. E. P. Martin, he shows how, by the enterprise of Bolckow, Vaughan and Co., Ltd., acting on the advice of the late Mr. E. Windsor Richards, the commercial and technical possibilities of the process were demonstrated to the world. He refers to some of the difficulties encountered, and indicates how, by the courage and persistence of Mr. Windsor Richards, success was finally achieved. He then traces the development of the process on the Continent, in Great Britain, and in America, and points out that the general tendency in recent years for the basic open-hearth to supersede the basic Bessemer is largely a matter of the wide distribution of suitable ores containing insufficient phosphorus for producing a pig iron suitable for basic Bessemer practice, and how this is especially noticeable in America, where 43,000,000 tons of steel were produced by the basic open-hearth process last year (1936).

The conditions under which the basic Bessemer had to operate in Britain with the ores available are sketched, and the reintroduction in this country of the basic Bessemer process by Stewarts and Lloyds, Ltd., at Corby, is referred to.

The author then deals with the influence which the basic process has had on the railway, shipbuilding, and engineering industries, and on the world as a whole, and points out that the present world production of basic steel involves the mining of not less than 250,000,000 tons of phosphoric ore per annum, which otherwise could not have been used for steel-making, and that since the introduction of the Thomas-Gilchrist basic process, it is estimated that not less than 22,000,000 tons of phosphoric acid as basic slag have been returned to the land to enrich the soil.

Finally, the author refers to Thomas as a man and the loss to the world by his early death.

A paper on "Hot Metal Practice in Five Melting Shops on the North-East Coast" was then read in abstract by Mr. W. Geary. The author gives the following synopsis:—

HOT METAL PRACTICE.

Attention has recently been called to the hot metal practice of the North-East Coast, of which no recent account has been published. This paper describes the methods in present use by reference to the construction and operating of five plants. Each plant is separately described and completely discussed. The history of each is briefly mentioned, and its subsequent development sketched. The plant lay-outs are described and adequately illustrated. The constructional details of mixers and varying designs of steel furnaces are mentioned and illustrated. The furnaces described vary from 55 tons to 250 tons capacity. Steel-making practice is described in detail for the various furnaces and plants, the lay-out of plant and design of furnaces necessitating certain modifications of practice. Data are supplied for complete charges, with accounts of analyses of materials and details of pressure measurements. Recent modifications in furnace construction are referred to; and a very fully detailed account is given of the author's experience when working the standard hot metal process in cold coke oven gas furnaces of modern design. The fuel consumption on these furnaces is given; for the more usual heating the gas supply and its utilisation are discussed and results are given. Casting practice is described and the nature of the products indicated. Certain observations are made concerning points that experience indicates to be of prime importance or of special interest, including the supply of materials, the effect of furnace design or shop lay-out, and fuel.

DISCUSSION.

Mr. James Henderson (director of the United Steel Companies, Ltd., deputy chairman, Appleby-Frodingham Steel Company, Ltd., and Past-President of the British Iron and Steel Federation) said that two of the shops discussed were of relatively modern design, whereas the other three represented improvements, adaptations, and developments of existing works, following our old-established British practice of carrying on as best we could with what we had got. The five shops had altogether a capacity of from 30,000 to 32,000 tons of ingots per week. Geographically, one was separate from the others, but four were almost within a stone's throw of each other, and one wondered why there were five when no doubt two would do the work better. The industry of the country must face that problem if it were to continue to occupy the position it should in the world's production of iron and steel. The fact that the basic Bessemer process, which was first developed commercially in the Middlesbrough district, had been discontinued there in 1919, was not due to lack of enterprise or energy. He supposed that the demand for basic Bessemer steel was then being filled by free imports into this country, and that it was commercially impossible to continue the manufacture here. But the manufacture of steel in the district was continued effectively by the basic open-hearth process. He suggested that there was room for both basic Bessemer and open-hearth steel in this country, that operations of tariffs and trade agreements might make it necessary for the country to reconsider the problem of manufacturing basic Bessemer steel, and that individual works and the British Iron and Steel Federation would give the problem due notice. But he submitted that open-hearth steel, and particularly basic open-hearth steel, was the kind of steel upon which the country must depend for its mass manufactures. In any district using lean ores, basic open-hearth steel ought to be made by the latest process—he had in mind the Talbot process, operating large tilting furnaces—at a cost probably not more certainly not substantially more than the cost at which steel could be made by the basic Bessemer process.

Mr. H. E. Wright (chief metallurgist, research department, Dorman, Long and Co., Ltd.) said that a considerable amount of sulphur could be removed in the open-hearth process, but that was not an economic proposition, and it involved delay. After trying high sulphur, high silicon, and everything else, he had found that the best method was to produce an iron in the blast-furnace which was satisfactory for conversion into steel. With regard to the various kinds of fuels used, Mr. Wright pointed out, in order that the main issue of the paper should not be lost sight of, that the Redcar works, which operated largely on producer gas, had a fuel consumption about as low as any of the others.

Discussing the future, he said that further progress in regard to the basic open-hearth process would be helped forward considerably by the production of a better type of refractory, for we were reaching the limit in respect of the refractories now available for the roofs and sides of the furnaces. At the same time he acknowledged that the Federation had recently put in hand some intensive work concerning refractories.

Mr. A. Robinson said that communications such as that by Mr. Geary allowed comparisons to be made which were not odious, and were the best counter propaganda against the inferiority complex which, until recent years, seemed to have beset all discussions of the British steel trade; they showed that the steel maker in this country could hold his own both in equipment and technical achievement with the steel maker of any other country. Mr.

Robinson noted with interest the fact that nowhere did Dorman, Long and Co. use mixed CO and blast-furnace gas without admixture, although they must have large quantities of those gases at their disposal; on the whole, they seemed to prefer producer gas enriched by a proportion of CO gas.

After giving, for purposes of comparison, some figures in connection with three 250-ton and one 300-ton furnaces fired with producer gas alone, and a 500-ton mixer heated with blast-furnace gas, making principally large ingots for plates, at the Appleby-Frodingham works (a further 300-ton furnace recently put into commission was not considered because it has not yet completed its first campaign), he drew attention to the particulars given in the paper of furnaces working with cold coke-oven gas and tar, and to the author's tentative opinion as to low upkeep costs. He asked, relative to the suggested effect of hydrogen in steel, whether the author could confirm that the steel produced in that type of furnace did not suffer from blow-holes more than the normal, and whether that type of furnace gave a similar yield of ingots to those fired with producer gas.

Mr. F. Bainbridge (works manager, Skinningrove Iron Company, Ltd., Saltburn) said that he noted that at Acklam it was the practice almost to empty the furnace into four 75-ton ladles, and asked whether the author considered that practice to be superior in speed of output and quality to the so-called continuous process in which the greater portion of the charge was left in the furnace when tapping a heat, and whether there was a big loss of dolomite when fettling between taps.

In connection with the use of mixed gas at Acklam, slag foaming trouble was experienced and the luminosity of the flame was not always maintained, it being suggested that the trouble was due to the moisture of the wet cleaned blast-furnace gas. He asked whether the author had endeavoured to increase the pre-heat of the mixed gas in the regenerators in order to improve those qualities.

Another matter on which he asked for the author's opinion was as to the value, if any, of the tilting furnace in strict comparison with a fixed furnace for the manufacture of ordinary commercial steels. Again, he asked for information concerning the economic working of the cold coke-oven-gas-fired furnace in comparison with the producer-gas-fired furnace.

Mr. H. S. Wood (chief metallurgist, South Durham Steel and Iron Company, Ltd., West Hartlepool) noted that on the 250-ton tilting furnaces at both the Acklam and the Britannia Works, where only 22 and 32 per cent. respectively of cold material was charged direct, the furnaces were practically emptied at each tapping; he suggested that large outputs would be secured by using the Talbot continuous process. In recent years, when scrap had been cheap and was used in large percentages in order to reduce the cost of the charge, it was better practically to empty the large tilting furnaces; but at present, in view of the scarcity of scrap and the larger quantities of molten metal employed, the continuous process should be considered seriously. Apart from the increased output, it resulted in less wear on the furnace bottom, a longer life to the steel ladle linings, and a more regular supply of hot ingots to the mills.

He recalled an occasion, about eight years ago, when he had visited a steel works in Germany in which a 250-ton tilting furnace, similar to those described in the paper, was operating on the Talbot continuous process and tapping 70-ton charges. Its output averaged 366 tons per day and about 2300–2500 tons per week (15–16 tons per hour). The cold material, which was charged direct, represented 25–30 per cent. The furnace drew its molten metal from two 800-ton non-active mixers, which were worked as receivers only, with no gas on them except at week-ends. The mixers also supplied the Bessemer converter. The average analysis of the iron into the receivers was:—Si, 0·7 to 0·8 per cent.; phosphorus, 1·9 per cent.; manganese, 1·6 to 1·7 per cent. The furnace was fired with a mixture of blast-furnace gas and coke-oven gas; the gases were mixed prior to their arrival at the plant, but extra coke-oven gas could be admitted at will just before the furnace valve. The gas checkers were worked at 1100 deg. to 1150 deg. Cent., and the air checkers at 1200 deg. to 1300 deg. Cent., and when keeping the gas regeneration above 1100 deg. Cent. no trouble was experienced in burning the gas and securing a clear luminous flame. Mr. Wood gave particulars of a charge worked on the furnace.

For the production of large outputs, he continued, which could be attained in the manufacture of mild structural steel, large mixers were necessary in order to secure a regular supply, in quality and quantity, of molten metal to the plant and to serve as a reserve, so that any stoppage or irregular working at the blast-furnace plant did not interfere with the open-hearth plant. With such facilities the continuous process again demanded very serious consideration.

Mr. Bainbridge corrected an apparent impression that a continuous process was operated at Skinningrove; it was found more satisfactory to take off four ladles and practically empty the furnace.

There was no time for an oral reply to the discussion, and the meeting adjourned until Thursday.

(To be continued.)

Engineering and Marine Exhibition at Olympia.

No. II.

(Continued from page 316, September 17th.)

WITH this issue we publish another large Supplement dealing with the Olympia Exhibition together with a four page Art Supplement. Below and in following issues we intend to describe various other interesting tools, machines and devices with which we have not yet been able to deal.

MAJOR, ROBINSON AND CO., LTD.

The tube bending machine shown in Fig. 10 is made by Major, Robinson and Co., Ltd., of 385–7, City-road, Manchester, 15.

As will be seen, it is electrically operated and is driven by a 3 H.P. induction motor through V belts and toothed reduction gearing. Six different ratios of speed can be obtained according to the size of tube being bent. The bend is effected by pulling a grooved former into the concave side of the bend by means of a long screw, while the ends of the pipe are supported by grooved pivoted stops. Two of these formers are shown in the foreground of the illustration. The machine is capable of bending steel pipes from ½in. to 4in. bore without heating or loading, and copper pipes up to 4in. when loaded. A clear view of the pipe is obtained during the process and pipes of any length can be bent.

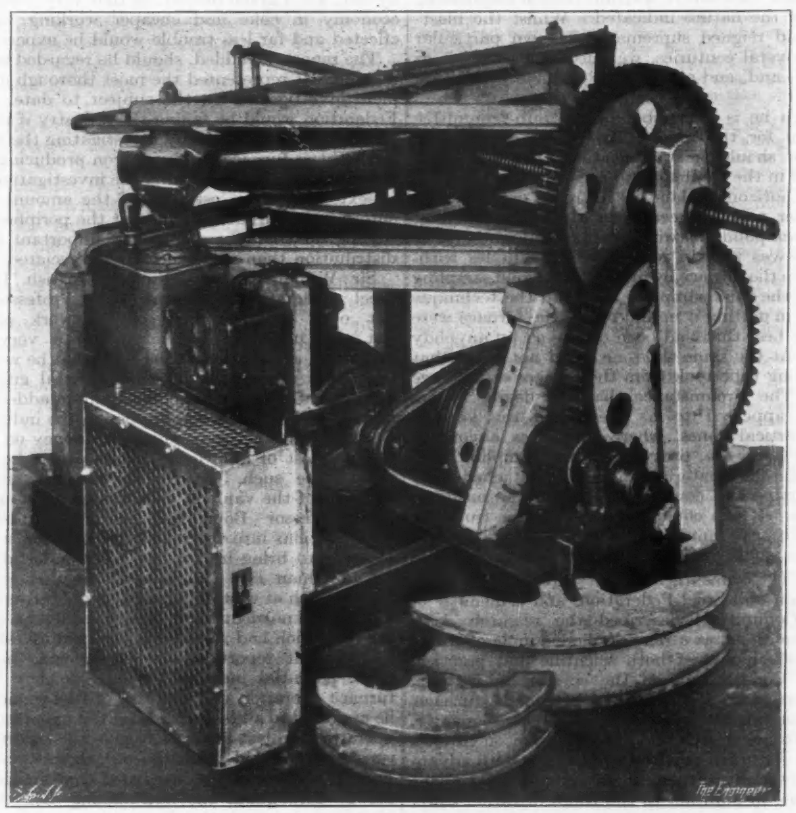


FIG. 10—TUBE BENDING MACHINE—MAJOR, ROBINSON

COOPER'S MECHANICAL JOINTS, LTD.

Many of the products of Cooper's Mechanical Joints, Ltd., of 14, Liverpool-road, Trading Estate, Slough, Bucks, are to be found on the stand, including various types of gaskets and shims, Kentonite, Cooperite, and other jointing materials.

The gaskets shown are made from copper and asbestos or in a laminated copper form. Asbestos will withstand the highest temperatures experienced in engineering joints and is unaffected by boiling water, oils, petrol, and the majority of acids and alkalies. Copper-asbestos gaskets are principally used for fire joints, but other uses are as oil pipe and oil filler gaskets, mountings for insulators in electrical and radio systems, superheater gaskets on locomotives. Solid copper gaskets can be used, but if greater resiliency be required the use of a gasket made from a number of thin copper sheets presents advantages. This form of gasket can be used repeatedly if re-annealed. Since the gasket consists entirely of metal with a high heat conductivity, with both surfaces in contact with the joint surfaces, its use avoids distortion arising out of two parts being maintained at different temperatures.

Kentonite is a material composed of cork sheets highly compressed and treated in order to render them proof against oil, petrol, water, and most chemicals, with a linen interleaf to give strength. Its chief use is for joints where the surfaces are rough machined or uneven. Cooperite is an asbestos jointing material which can be finished with a graphite surface and is thus suitable for steam and gas joints. Oakencork is a material made from cork granules and manilla rope fibre, combined with adhesives. It is claimed that a jointing material is thereby produced which possesses the elasticity of cork and the strength of vegetable fibre. It is proof against the effects of petrol, water, and hot or cold oil, and is supplied in rolls 42in. wide and in a range of thicknesses from 0·01in. to 0·125in.

F. J. EDWARDS, LTD.

The firm of F. J. Edwards, Ltd., of 359–361, Euston-road, London, N.W.1, has on show a number of sheet metal working machines, such as a press for making tin-plate box blanks with a fabricated plate frame and a new overcrank type of guillotine for plate up to $\frac{3}{16}$in. thick by 6ft. wide. The latter machine has a cam-operated, spring-loaded hold-down, which enables the operator to watch the plate as it is being sheared. This hold-down is sufficiently powerful to hold together several thicknesses of light plate for simultaneous shearing, provided the maximum thickness is not exceeded.

HENRY WIGGIN AND CO., LTD.

The most important exhibit on the stand of Henry Wiggin and Co., Ltd., of Thames House, Millbank, London, S.W.1, is a segment of a turbine rotor fitted with the new integral root Monel blading recently developed and manufactured at the Zenith Works of the company. As the name implies, the root is integral with the blade and it is claimed that the production method is such that there is a smooth-flowing grain structure.

Grooves are milled in the blade roots so as to fit into the corresponding grooves in the rotor rim. After insertion each blade is locked in position by turning it through approximately 45 deg. In this manner the building up of blade segments by means of brazing or silver soldering to loose packing pieces is eliminated.

Other exhibits include many products embodying Monel in their construction. Riveted and welded types of pickling crates are shown, such as can be used for the pickling process of steel sheets prior to enamelling. Welded Monel link chains are used for slings for the pickling of steel rods and tubes. For comparison a steel chain is shown which has become

heavily corroded after only a few days' service.

Of interest to aircraft engineers are exhaust manifolds made from "Inconel." This recently developed nickel-chromium-iron alloy has, it is said, a high resistance to the corrosive elements present in the combustion products of leaded fuels. It is claimed that "Inconel" is, in addition, immune from heat oxidation at temperatures as high as 900 deg. Cent.

FULLER ELECTRICAL AND MANUFACTURING COMPANY, LTD.

The stand of the Fuller Electrical and Manufacturing Company, of Fulbourne-road, Walthamstow, E.17, is divided into two sections, one devoted to arc welding and the other to resistance welding. All the machines are shown in operation and demonstrations are being given of the Fuller Carbo-Flux arc welding process for light sheet metal work. Copper, mild steel, and stainless steel down to 22 gauge are being welded in accordance with this process by the semi-automatic and hand methods, which give good appearance and freedom from distortion. By means of a new high-power electrode, $\frac{3}{8}$in. and $\frac{1}{4}$in. plate are being welded without bevelling. With the new electrode much higher arc powers are employed than usual and full penetration is obtained in unchamfered plates up to $\frac{1}{2}$in. thick.

Most of the arc welding equipments shown are familiar to our readers, but attention may be called to the semi-automatic Carbo-Flux welding machine shown in Fig. 11. The Carbo-Flux welding process consists of arc welding by means of a carbon electrode, which is held in a special holder, and is connected to the negative pole of a suitable D.C. welding generator. The work to be welded is connected to the positive pole, and the arc is maintained much in the same way as in ordinary metallic arc welding. Special fluxes are used to facilitate striking and maintaining a steady arc and to prevent the inclusion of oxides or nitrides. For welding longitudinal seams automatically, the machine shown in Fig. 11 is suitable. It consists of a semi-automatic welding head mounted on a small motor-driven travelling carriage which runs on an angle iron track and the carriage is provided with gearing giving varying welding speeds to suit different thicknesses of metal plate and types of joints. When making welds in circular tanks, &c., the work is rotated and the welding head fixed. On the welding head of both the stationary and fixed types there is a push button which operates a contactor controlling the welding current, and is used at the beginning and finish of a weld. Its chief function is to avoid accidentally short-circuiting the electrode with the work when loading and unloading the machine. Owing to the carbon burning away at a rate of only approximately $\frac{1}{4}$in. per foot of weld, no automatic feed is provided for the carbon. The arc length is maintained substantially constant by occasional adjustment of the hand wheel for the carbon feed. The D.C. generators used for supplying the machines with current have the necessary volt-ampere characteristics and fine current adjustment can be made. The welding head is water cooled, and has an electro-magnetic arc-directing coil. In the centre of the head is the electrode holder, which terminates in an adjustable clamp for carrying the carbon electrodes, which are normally $\frac{5}{32}$in., $\frac{3}{16}$in., or $\frac{1}{4}$in. in diameter. At the bottom of the welding head the current is transmitted to the carbon electrode through spring contacts connected to the cooling water nipple.

Standard pedal-operated resistance welding machines are supplied with or without current-control devices, and are produced in a sufficient number of sizes to cover all requirements. The machine shown in Fig. 12 is a 20-kVA combined spot and seam welder with 30in. arms, a ten-position current regulator, welded steel frame, automatic trip switch and contactor, and a synchronous interrupter. When the machine is used for seam welding the tripping switch is inoperative. The electrodes can be arranged longitudinally or transversely for welding seams or the ends of drums. Two thicknesses of 16 gauge metal can be welded.

Among other resistance welding machines on view is a 55-kVA compressed air operated spot welder, with 40in. arms. Like the 20-kVA machine, it has a welded steel frame, a ten-step current regulator, and an automatic trip switch and contactor. It is capable of welding two thicknesses of $\frac{1}{2}$in. plate with pressures up to 660 lb.

ARTHUR LYON AND CO.

For those interested in portable petrol-electric generating sets, the display of Arthur Lyon and Co., of Africa House, Kingsway, is of great interest. Three of these units are shown, as well as an alternative pattern of the largest set, which has an output of 1250 watts and weighs 150 lb. This unit is really a marine version of the portable set of the same output. It has been designed for use on motor patrol boats, aircraft tenders, and similar vessels, where weight and space are important. The engine is a horizontally opposed, four-stroke, twin-cylinder, air-cooled set; the exhaust, however, is water cooled. The cylinder capacity is 300 c.c. and $2\frac{3}{4}$ B.H.P. is the specified output at 1750 r.p.m. Approximately 1500 watts is generated at 1750 to 2000 r.p.m. continuously with a shunt-wound D.C. generator of the battery charging type. In addition, generators of the compound-wound type for direct lighting, dual-voltage D.C. of high and low-tension for wireless sets, self-exciting A.C. generators, or high-cyclic machines for geophysics research can all be fitted. The fly-wheel fan used for cooling has been designed for use in tropical climates. The side valves are completely enclosed in dustproof casings, and are operated by a cam shaft carried on ball bearings. A governor controlling the engine revolutions per minute within 4 per cent. is fitted, together with an instantaneous adjustment of the "tick-over." Accessibility has been carefully studied. The cylinder heads are detachable; the crank case is made in two parts, one of which may be removed without dismantling any of the running gear. The magneto has a quickly released coupling, and only the petrol feed is carried in external piping. Automatic pressure lubrication of the dry sump type is used, so that if the engine is turned over or set up badly the oil level is not affected. A separate cooling sump is used in conjunction with an exhaust pump. The generator is of the drip-proof protected type, with gauze covered air inlets on its underside. A water-proof cable socket and cap are fitted. The portable version of the set is mounted on an aluminium alloy base plate, which can be arranged with a tubular frame carrying the petrol tank and having two-pole carrying fixtures. The set in this condition weighs approximately 160 lb., and is 20in. high, 23in. long, and 11in. wide.

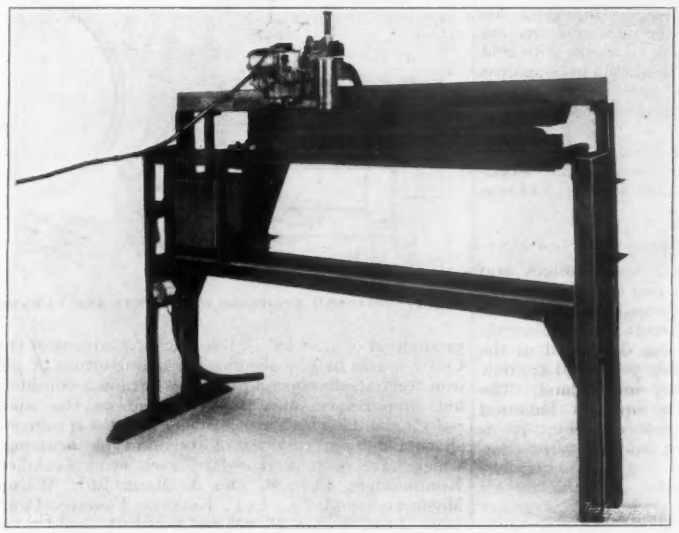


FIG. 11—SEMI-AUTOMATIC "CARBO-FLUX" WELDING MACHINE—FULLER

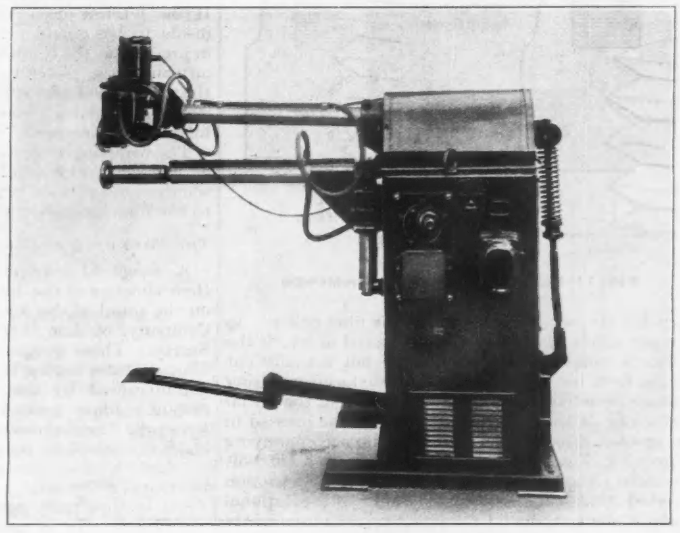


FIG. 12—COMBINED SPOT AND SEAM WELDER—FULLER

Illustrated in Fig. 13 is the 400–500-watt portable generating set, as supplied to the Mount Everest 1936 Expedition for battery charging. As shown, it has a weight of 120 lb., and is of the standard type, except that the compression ratio was raised and that coil ignition was fitted. The standard engine has a cylinder capacity of 169 c.c. and delivers 1·75 B.H.P. at 1750 r.p.m. The generator delivers 550 watts at 35 volts. The engine is a single-cylinder unit with completely enclosed overhead valve gear. The automatic lubrication already described is fitted, and the same general specification applies. For transport purposes the set complete on its bed-plate has a weight of 125 lb., and can be carried by porters by means of a pole fixture. For pack saddle transport, however, the unit may be subdivided into two loads, each weighing about 65 lb. or 70 lb. In one load is the engine without the bed-plate, and either the switchboard or a spare can of petrol; the other consists of the generator and the bed-plate, the generator being shifted to the centre of the bed-plate for balance, the petrol

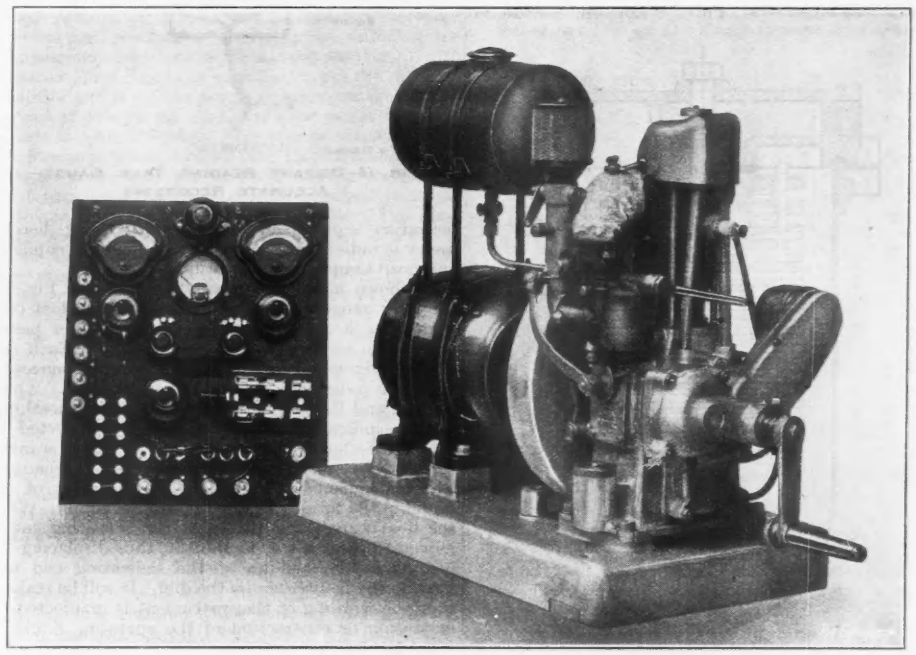


FIG. 13—500 WATT PORTABLE GENERATING SET—LYON

tank, and the silencer. The dismantling of the engine from its bed-plate, freeing the coupling, and shifting the generator is a job taking only a few minutes.

SIMMONDS AEROCESSORIES, LTD.

On the stand taken by Simmonds Aerocessories, Ltd., of the Great West Road, Brentford, London, are shown a number of specialised engineering accessories, including the Simmonds elastic stop nut. This nut is a standard nut with its height slightly increased so as to enable a fibre collar to be inserted in an annular groove. The collar is not threaded and has an internal diameter slightly less than the diameter of the bolt. When the bolt has passed through the threaded portion of the nut

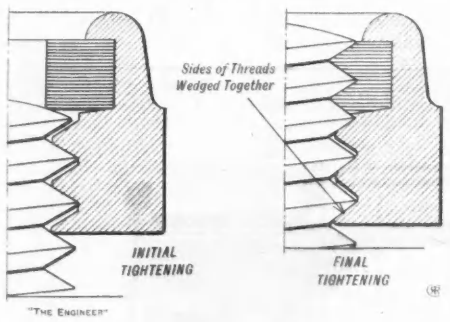


FIG. 14—ELASTIC STOP NUT—SIMMONDS

it makes its own thread through the fibre collar. As a result of the elasticity of the material of which the collar is composed the threads are not actually cut by the bolt, but the material is pressed aside, causing friction between the threads. In addition, the initial tightening of the nut causes the nut to be pressed in an upward direction, as shown in the accompanying engraving, Fig. 14. It is claimed that on a $\frac{3}{8}$in. bolt the axial force amounts to about 700 lb. The friction exerted thus causes a considerable anti-rotational force if the nut should tend to turn. Consequently these nuts are of use wherever vibration occurs and where previously a locked nut has been required. This type of nut is largely used by aircraft manufacturers.

The Simmonds-Corsey transmission system, also shown on the stand, is a push-pull system, capable, it is claimed, of transmitting loads over considerable distances with efficiency. It is applicable to a number of uses, particularly for motor car and aircraft control operation. Also shown is a range of Simmonds-Goudime navigational instruments and a jointing compound which is said to be heat resisting up to a temperature of 400 deg. Fah. and to be non-soluble and non-corrosive.

VOKES, LTD.

Shown on the stand of Vokes, Ltd., of 95–105, Lower Richmond-road, Putney, London, S.W.15, is

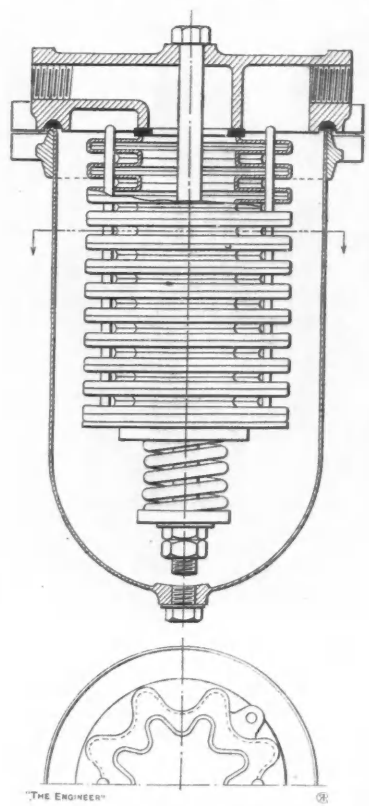


FIG. 15—METAL PACK OIL FILTER—VOKES

the new metal pack oil filter illustrated by Fig. 15 herewith. This filter is claimed to be a more durable unit than the commonly used fabric and gauze types. On account of its all-metal construction and the absence of moving parts, repeated cleaning and dismantling cannot cause wear or impair its filtering properties.

The filtering element is composed of a number of star-shaped pierced plates, so as to provide as large a filtering surface as is possible. The inner and outer edges of each plate are raised to form two concentric beadings about $\frac{1}{8}$in. wide. The faces of these beadings are ground flat, so that when a number of plates are placed on a central retaining rod alternate faces are in contact. The plates are held by two guide rods, which pass through holes in lugs in each plate. The lugs are situated outside the outer ground faces, and thus oil which leaks through the guide rod holes cannot enter the clean oil side of the filter. The ground faces are held in contact by means of a compression spring, the pressure exerted being controllable by means of an adjusting nut on the retaining rod. If the filter is used with the oil flowing from the inside to the outside of the filter pack, an increase in pressure as the result of starting an engine with cold oil causes the plates to curve apart slightly against the pressure of the spring. As soon as the oil gets warm, the plates close up and the fineness of the filtration is increased.

The company is showing a wide range of filters for oil and air, and a number of exhaust and air intake silencers for various types of machinery, in addition to the filter described above.

THE ACCURATE RECORDING INSTRUMENT COMPANY.

A range of "Liquidometer" tank gauges and thermometers of the distant-reading type is exhibited on the stand of the Accurate Recording Instrument Company, of Aric Works, Oakcroft-road, Tolworth, Surrey. These gauges have been developed in the United States during the past few years and are now manufactured by this company in England. The distant-reading gauges operate upon a balanced hydraulic transmission system, whereby, it is claimed, complete temperature and pressure com-

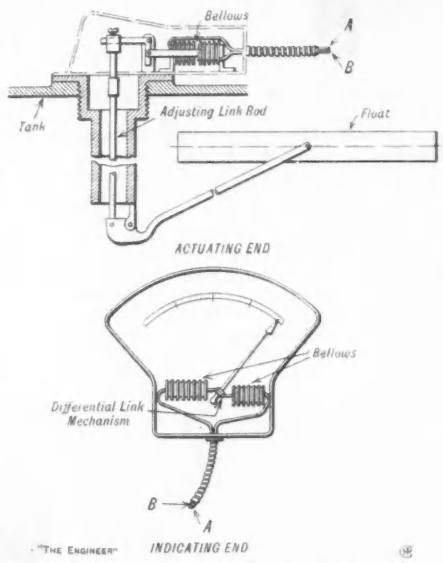


FIG. 16—DISTANT READING TANK GAUGE—ACCURATE RECORDING

pensation is provided. The distant-reading thermometer is individually compensated for both capillary and head temperature variations.

As shown in the accompanying engraving, Fig. 16, the tank gauge is operated by means of a float connected by a suitable link mechanism to a piston working in an enclosed bellows cylinder. Each end of the cylinder is provided with a pipe connecting with the indicating end of the instrument. These pipes A and B are enclosed in a protective sheathing. At the indicator end the pipes are connected to separate bellows, each with a piston which is interconnected by means of a differential link mechanism. The instrument works by the displacement of the liquid in the totally enclosed hydraulic circuit. When the float moves, the piston at the actuating end is moved to the right or to the left, thus displacing the pistons in the bellows at the indicating end and moving the pointer across the dial. It will be realised that the working of the instrument is unaffected by expansion or contraction of the operating liquid as a result of temperature or pressure variations, since the change of volume in one tube will always be compensated for by a like change of volume in the other.

The distant-reading thermometer works on the same principle. The actuating bellows in this case is connected by means of tubing to a bulb or sensitive element and a change of temperature at the bulb causes a contraction or expansion of the liquid, which is transmitted to the actuating bellows. As described above, variations in temperature along the communicating tubing affects the liquid inside the tubing and the bellows equally, as the circuit is balanced except for the liquid inside the bulb. With this instrument there is a third bellows at the indicating end connected to the actuating and balancing bellows, which automatically compensates for any difference of volume of liquid in the two bellows at the indicating end. The means of eliminating errors as a result of temperature changes at the indicating end is thus provided.

The range of instruments exhibited by the company also includes direct-reading models of the tank gauge, suitable for direct attachment to the tank, and temperature, pressure and vacuum recorders and other instruments.

STEWARTS AND LLOYDS, LTD.

The name of Stewarts and Lloyds, Ltd., whose London office is in Kings Buildings, Dean Stanley-street, Westminster, is usually associated with the

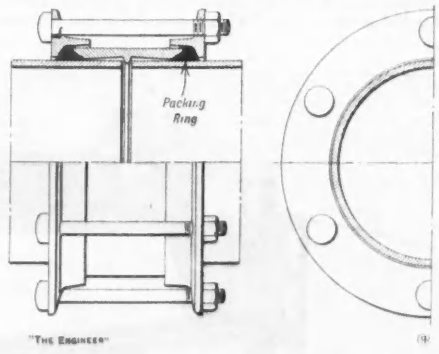


FIG. 17—JOHNSON COUPLING—STEWARTS AND LLOYDS

production of steel tubes, but since the advent of the Corby works in Lincolnshire the manufacture of pig iron for outside consumption has attained considerable importance, and is exemplified on the company's stand. There are various fractured specimens showing different qualities of iron and typical castings which have been produced by such firms as Allied Ironfounders, Ltd., R. and A. Main, Ltd., Walter Macfarlane and Co., Ltd., Emscote Foundry Company, Ltd., Sydney Flavel and Co., Ltd., and Crane, Ltd. There are also specimens of the raw materials

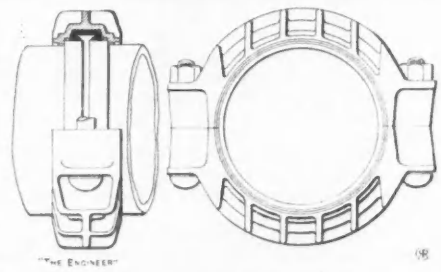


FIG. 18—"VICTAULIC" JOINT—STEWARTS AND LLOYDS

used in the ironworks and of such by-products as road-making metal, basic slag, &c.

The tube exhibits hardly need reference, but there is something interesting in a telescopic steel shore, which can be used, for instance, in the dockyard for propping up ships. Its length can be adjusted by a bayonet catch, and its use saves the space generally monopolised in dockyards by great stacks of timber shores.

In connection with the display of tubes the company is showing examples of three alternative pipe joints. These pipe joints are illustrated by Figs. 17 to 19.

The Johnson coupling (see Fig. 17) has the merits that it can be applied to pipes with plain

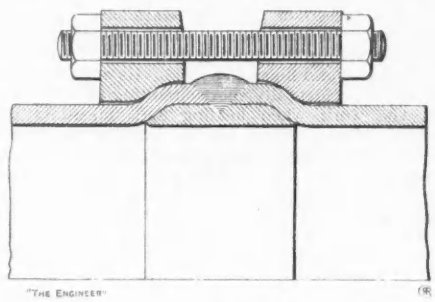


FIG. 19—DAWSON JOINT—STEWARTS AND LLOYDS

straight ends and also allows a certain degree of flexibility in the pipe line; that is to say, each joint can be flexed through an angle of some 6 deg. without leakage, even at pressures up to 2000 lb. per square inch, so that curves with a radius of 65 yards can be negotiated with 20ft. lengths. The construction of the joint is so obvious in the drawing as to need no description, but it should be pointed out that the soft packing ring which is wedged between the steel sleeve and the pipe end may be made of various materials according to the requirements of the service.

The Victaulic joint, Fig. 18, is probably familiar to most of our readers, and is an adaptation of the

principle of the hydraulic cup leather. A double-sided cup, which is generally of a rubber composition, is held in place over the joint by a split housing and automatically keeps tight regardless of the pressure. A slight degree of flexibility and longitudinal movement is permitted. The Dawson joint, Fig. 19, is of the rigid type, and is intended for steam at high temperatures and pressures. It is, it will be seen, made by belling out the ends of the pipes and welding them together over an internal nipple. Bolted flanges can be used to reinforce the joint, but are not always necessary.

M. AND C. SWITCHGEAR, LTD.

Industrial switchgear of various kinds is exhibited by M. and C. Switchgear, Ltd., of Kelvinside Works, Kirkintilloch, Glasgow. The push-button "Straight-on" motor starter, Fig. 20, has a constant rating capacity of 30 amperes, and is capable of starting motors with a standstill current up to 100 amperes of the following ratings:—5 H.P. at 220/250 volts, 10 H.P. at 400/440 volts, and 15 H.P. at 660 volts. It has a totally enclosed, three-phase contactor and three-pole adjustable thermal overcurrent trips. The start and stop contacts are supported from the main base, and only the push-buttons are assembled in the cover. No flexible connections are carried round the hinge of the enclosure. All live parts are carried on the base mounted in the case. The starter can be arranged for local, remote, float, or limit-switch operation. If it should be necessary to remove the contactor-operating coil the withdrawal of a split pin from the stop, which limits the travel of the moving parts, makes it accessible, when the coil can readily be removed. An isolating switch is incorporated when specified. Three types of enclosure are available. A totally enclosed type is for general factory use, a hoseproof type is for service in dairies, dye works, laundries, &c., and a flameproof type for petrol depôts, rubber works, cellulose plants, and also for use in mines where Regulation No. 132 applies.

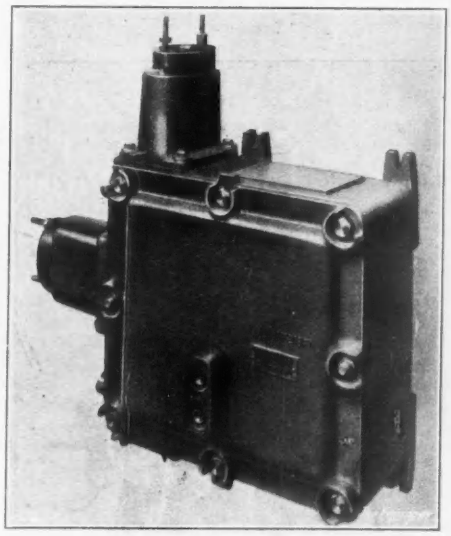


FIG. 20—"STRAIGHT-ON" MOTOR STARTER—M & C

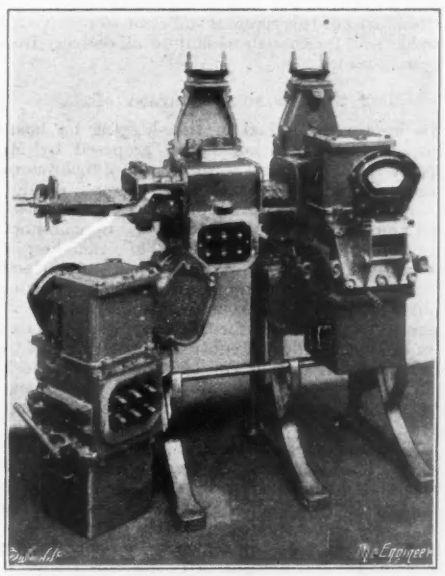


FIG. 21—FLAMEPROOF OIL-BREAK SWITCHBOARD—M & C

A switchboard designed for mining service, incorporating Buxton service circuit panels, is shown in Fig. 21. The 200-ampere panels have over-current, under-voltage, and leakage protection gear, and pedestal-mounted ammeters. Special features of this gear are a flameproof air-insulated connection chamber between bus-bar chambers; panels may be added or removed without interfering with the compound; a cable-earthing switch for earthing the outgoing feeder is fully interlocked with the breaker; mechanical interlocks make the gear mistake-proof; roomy cable boxes and terminal chambers facilitate installation, and a flameproof chamber encloses draw-out contacts.

Among other exhibits is the flameproof slip-ring motor starter shown in Fig. 22. Designed to comply with the Mines Department requirements, the starters are made in two sizes. The No. 1 size allows for full-load rotor currents up to 100 amperes, and the No. 2 size 200 amperes. The horse-power ratings for the No. 1 starter are 25, 50, and 65 at voltages of 220, 400, and 600, and those of the No. 2 starter 50, 100, and 125 at the same respective voltages. The starters are made for two and three-phase supplies with the fourth wire in the former case passing straight through. No. 1 size starter has a triple-pole stator contactor, two double-pole rotor contactors, two timing devices, three adjustable thermal over-current trips, three short-circuit protection fuses, and a triple-pole isolating switch. With the exceptions that the No. 2 size starter is devoid of the short-circuit protection fuses and that the overload trips are of the magnetic type, the equipment is the same as that of the No. 1 size starter.

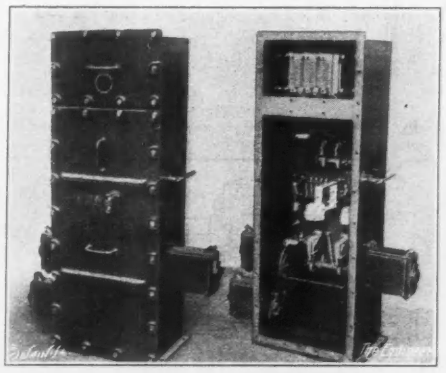


FIG. 22—PUSH BUTTON STARTERS—M & C

PILKINGTON BROTHERS, LTD.

Various forms of toughened glass are shown on the stand taken by Pilkington Brothers, Ltd., of St. Helens, Lancs, and a comprehensive display of the uses of "Armourplate," "Toughened," and "Armourlight" glasses is arranged.

"Armourplate" glass is heat-treated polished plate glass, possessing, it is claimed, greatly increased thermal and mechanical strength, but retaining the transparency and flatness of surface associated with polished plate glass. In addition, it has fire-resisting qualities and is said to provide protection against the spread of fire for at least one hour when correctly glazed in metal frames. For use in ships it offers resistance to wave shocks; the manufacturers state that a thickness of ¼in. will withstand a pressure at least four times as great as that required to break ordinary plate glass 1in. thick. If broken, this glass disintegrates into small pieces not sharp enough to cause serious injury. Demonstrations are given on the stand showing how "Armourplate" glass resists twisting and bending stresses, impact, and extremes of temperature.

The toughening process employed can also be applied to many other types of glass, including tinted polished plate, black glass, figured and cathedral glass, &c. These glasses are marketed as "Toughened" glass and have heat-resisting properties.

One of the most recent products of Pilkington Brothers is "Armourlight," the name given to various blown and moulded glasses to which the toughening process has been applied. These products include electrical insulators, roof and pavement lights, bulkhead glasses, &c.

GRIMSTON ELECTRIC TOOLS, LTD.

A varied range of small electrically driven drilling and grinding machines and sanding and polishing equipment is shown by Grimston Electric Tools, Ltd., of 138, Lever-street, London, E.C.1. "Electriska" high-production drilling machines are represented by the example shown in Fig. 23. These machines are directly driven by means of a built-in electric motor, through gears giving four speeds. The levers which operate these gears can be seen, mounted on the head of the machine, in the engraving. In addition, three sets of change wheels can be provided, which enable twelve drilling spindle speeds to be obtained in all, ranging from 200 to 3600 r.p.m. It is claimed that the change wheels can be removed and replaced in only 30 sec., since they slip into place without the need for tools. The machine is provided with a depth stop. Longer columns than that shown in the engraving can be supplied. The column is 4in. diameter and the capacity of the machine is up to 1in. The spindle is carried in ball and roller bearings, and the height adjustment is effected by means of a rack and pinion.

The "Quadruflex" machine for mechanical sanding, rubbing down, and polishing cellulose is shown in Fig. 24. The preparation of metal by sanding, the rubbing down of cellulose, and the final polishing calls for the use of widely different speeds. A flexible shaft machine is in general more suitable for this kind of work, since the weight in the operator's hands is reduced to a minimum. The machine shown in Fig. 24 is of the flexible shaft type, and is made in two sizes, with sanding discs of 7in. and 9in. diameter.

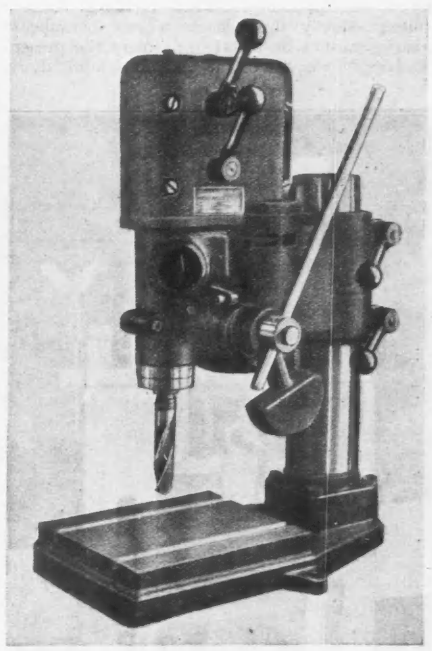


FIG. 23—DRILLING MACHINE—GRIMSTON

The continuously rated horse-powers of the driving motors are 0·75 H.P. and 1 H.P. respectively. Four standard speeds, ranging from 900 to 3500 r.p.m., are provided, although, by the use of two extra pulleys, an alternative speed range from 1000 to 8000 r.p.m, can be obtained. As can be seen from the engraving the driving motor is mounted in swivels on a transportable pedestal base. The drive is taken from the motor spindle to the flexible shaft by means of a belt and the four-stepped pulleys mentioned above. In addition to the operations of sanding and polishing, these machines can be used for sheet metal cutting wire brushing, grinding, buffing, and decarbonising.

Other exhibits on the stand include double-ended grinding machines and special machines for the grinding of tungsten carbide tools, electric drills with capacities ranging from ¼in. to 1in. and single and multi-speed flexible shaft grinding machines.

FIG. 24—"QUADRUFLEX" SANDING MACHINE—GRIMSTON

WESTINGHOUSE BRAKE AND SIGNAL COMPANY.

Since the last Engineering Exhibition considerable advances have been made in the design and manufacture of metal rectifiers, and the exhibits of the Westinghouse Brake and Signal Company, of 82, York-road, King's Cross, represent the latest practice. There are rectifiers for electro-plating, battery charging, and general industrial purposes. One of the principal exhibits is a rectifier in operation for the supply of current to plating vats. The exhibit demonstrates the good current regulation obtainable with the firm's new equipment, and the economies

secured in running costs are shown by the measurement on the stand of the current input with a watt-hour meter. Other typical applications, including battery charging and the operation of a D.C. suspension magnet from A.C. mains, are demonstrated.

C. C. WAKEFIELD AND CO., LTD.

Special appliances as well as materials for the lubrication of machinery have long been a study of the firm of C. C. Wakefield and Co., Ltd., of London. This year is exhibited, among other appliances, the special device shown in Fig. 25, for lubricating the driving chains of conveyors. Although apparently a simple problem, the design of a device of this nature requires careful study. The conveyor chain is travelling slowly in places where complicated auxiliaries cannot be installed; where the presence of oil drippings is out of the question; and where a

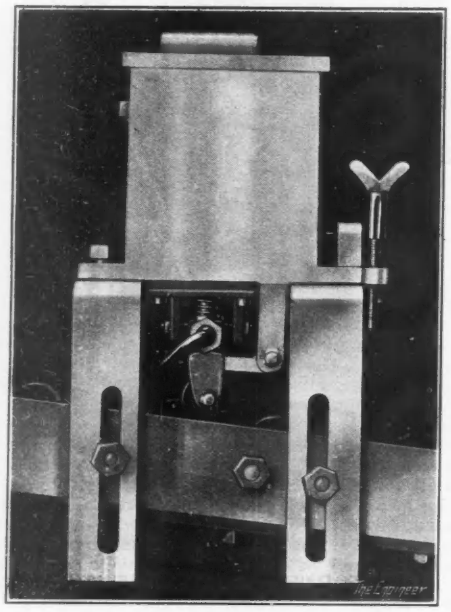


FIG. 25—CONVEYOR CHAIN LUBRICATOR—WAKEFIELD

minimum of attention can be given. At the same time, the number of moving parts, the complication of the modern conveyor lay-out, and the high loading—often varying greatly as well—makes the problem a difficult one. The distances covered alone require the installation of several devices at widely spaced intervals, so that the apparatus has to be cheap and robust.

The Wakefield conveyor chain lubricator operates as shown in the two sections, Fig. 26. As each chain roller travels past it the pump roller is lifted on the periphery of the chain roller. This pump roller operates a rocker lever which provides adjustment for the length of stroke, and through it the lubricant pump itself, forcing the pump plunger into the barrel. The oil is forced down the centre of the plunger, and past the delivery ball valve at the bottom to the delivery oil pipes shown. These pipes are mounted in ball and socket joints so that the oil drip emerging from each can be accurately set to the right position. When the chain roller has released the pump plunger, which is returned by means of a spring, oil is drawn into the pump barrel past the two suction ball valves through a small strainer from the reservoir casing. This casing is of adequate size to avoid too frequent filling and is fitted with a full-size lid at the top to allow it to be refilled easily and rapidly. A large gauze strainer is provided to trap impurities in the incoming oil. When starting up an initial oil feed may be given by hand by means of the projecting rocker lever, which also acts as a regulator of the stroke. When the pump is started air is released through the ball valve fitted in the pump barrel head and leading to an air release tap above the reservoir oil level. The flow can thus be checked at this tap. To adjust the pump the screwed stop on the rocker lever is used to reduce the stroke of the pump. By this means the delivery can be varied from 0in. to ½in. stroke. Installation is easily arranged—as shown in both illustrations—by means of two brackets. The only exactness required is to ensure that the pump roller rides centrally on the conveyor chain roller and is given a lift of not more than ½in.

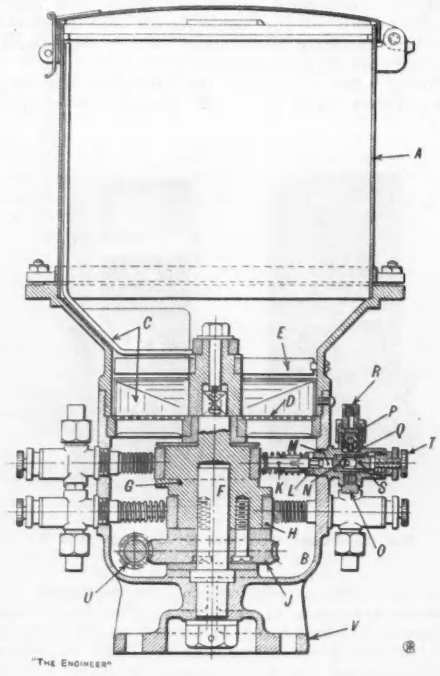


FIG. 27—LUBRICATOR FOR ROLLING MILL—WAKEFIELD

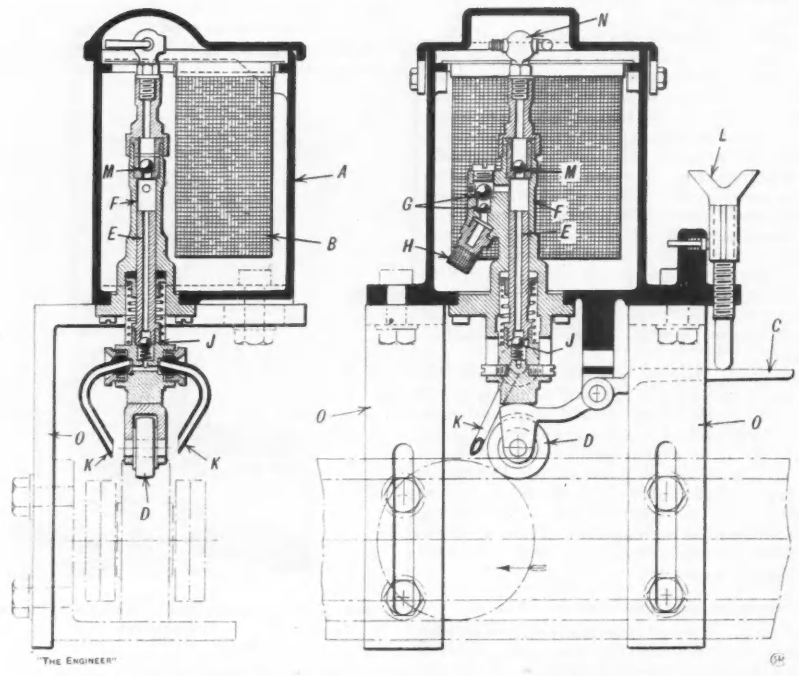


FIG. 26.—SECTIONS THROUGH CONVEYOR CHAIN LUBRICATOR—WAKEFIELD

Also on view on this stand is the mechanically operated grease lubricator for large rolling mills or similar machinery, illustrated in Figs. 27 and 28. Containers of 10 lb., 20 lb., 35 lb., or 50 lb. capacity are available and the drive may be by ratchet, chain, gearing, or separate motor. As shown in the section Fig. 27, the drive shaft operates an excentric shaft by worm reduction gear. Two excentrics are provided, one above the other, and each is fitted with a loose excentric sleeve. On the top end of the shaft is provided a revolving scraper and scoop, which eliminates air pockets and feeds the grease from the upper reservoir into the pump chamber itself through a strainer fitted immediately beneath it. A stationary blade assists the feed of the scoop. Up to fourteen feeds in the smaller sizes and up to twenty-four feeds in the larger are arranged round the two excentrics, each one consisting of a pump independently detachable and adjustable even when the lubricator is operating without reference to the other units. Pressures up to 5000 lb. per square inch are attainable and at each stroke each pump delivers from zero up to 0·02 cubic inches of grease, according to adjustment. The grease is picked up from the pump chamber through ports in the bottom of the pump barrel, which are closed by the pump plunger. The grease is then forced through the outlet valve set in the union of the outlet pipe. An air release operated by a stud on the pump piston itself allows any air to escape through an air vent fitted in the test plug shown below the outlet valve and on the opposite side of the pump barrel head. This plug may also be used to test the grease flow. The pump plunger is made in two halves, loosely jointed together, so that side thrust is taken by the lower member, which acts as a crosshead while the upper member acts as the plunger proper. The effect of side thrust is further reduced by making the pump body of nickel-iron alloy. The pump units are each adjustable by the thumbscrew shown, which sets the position of the cylinder head in relation to the plunger. Being of larger diameter than the plunger, one and three-quarter turns of this screw is sufficient to remove the cylinder head far enough to shut off all delivery from the pump unit.

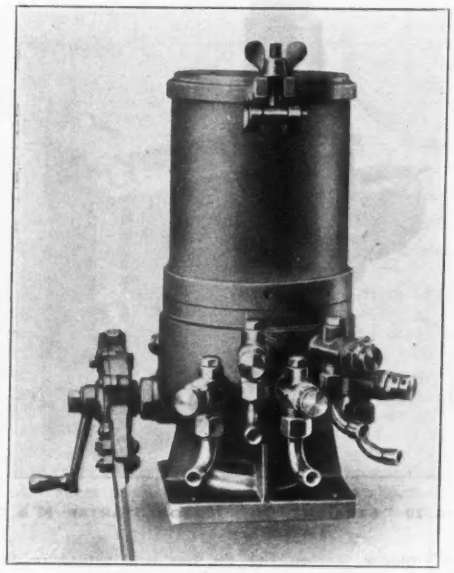


FIG. 28—LUBRICATOR FOR ROLLING MILL—WAKEFIELD

THE SYNCHRONOME COMPANY, LTD.

An improved method of time-keeping on board ships, particularly ocean liners, proposed by Mr. Hope-Jones in 1933, is shown by the Synchronome Company, Ltd., of 32–34, Clerkenwell-road, London, E.C.1. Visitors to the Exhibition in 1935 will recall the demonstration given by the Synchronome Company of a new method of time-keeping on board ship in which synchronous motor clocks are used instead of the more familiar electrical impulse dials. It is now customary to provide a small separate A.C. generator for this duty, and by means of an original method of controlling the speed of the alternator the frequency can be varied and the clocks made to keep true time throughout the voyage, automatically compensating for the changing longitude of the ship.

Experience has suggested many improvements since the invention was first made known. The set demonstrated embodies the latest method devised for automatically compensating for variations in voltage as a result of fluctuating loads on the ship's D.C. supply, so that once the controller is set at a given frequency by the navigating officer this frequency will be maintained until the variation in the speed of the ship or the course demands that it should be altered. The set exhibited is intended for a small vessel requring not more than fifteen clocks, but larger sizes, accommodating several hundred clocks, are available.

A further advantage of this method is that distribution throughout the ship is simplified, since all clocks are connected in parallel, preferably to a ring main on each deck. Irregularities due to disconnection—an ever-present risk in series circuits of electrical impulse dials—are thus eliminated.

On this stand are also to be found exhibits of the Synchronome standard master clock for land installations and the ordinary marine master clock for ships equipped with electrical impulse dials.

(To be continued.)

Strain and Stress Distribution in Doubly Reinforced Concrete Beams.

By R. H. EVANS, M.Sc., Ph.D., Assoc. M. Inst. C.E.

IN a previous article attention was devoted to the distribution of strain and stress in plain and singly reinforced concrete beams. In this article it is proposed to discuss the results of tests carried out on doubly reinforced concrete beams. The strain measurements were obtained by means of mirror and dial extensometers, of 8in. gauge length, in the middle third portion of the beam, all beams being loaded at the middle third points. Readings were taken at zero load and at a number of increasing and decreasing loads in each cycle of loading, the maximum load being often sustained for several days in order to allow some of the creep or time strains to occur. The readings of the extensometers were taken as quickly as possible after the application or removal of the load, so that it is possible to plot either the total strains or the repeated strains along the depth of the beam at any stage of the tests and to determine the magnitude of the permanent set at zero load after the sustention of any load.

EXPERIMENTAL RESULTS.

A selection of the strain distribution curves obtained is given in Figs. 1–4. There are many salient features present in all the diagrams irrespective of the mix and of the percentage of compression reinforcement. For example, at a load of 1 ton the strain distribution curve for all the beams is sensibly linear, and the observed position of the neutral axis agrees satisfactorily with that deduced, including the tension in the concrete. Up to this load the beams behave like homogeneous beams with an equivalent area of concrete substituted for the steel reinforcement. It will be shown later, when balancing the internal forces, that very fine hair cracks were actually present at this load of 1 ton as it is impossible to balance the internal forces assuming a linear distribution of stress. Consequently, a linear distribution of strain is often no definite criterion that the concrete in tension has not cracked. Thus in Figs. 1 and 2 the strain distribution is practically linear under loads of 4 tons, the elastic stress in the tension reinforcement being then about 18,000 lb. per square inch, while in Fig. 4 the strain distribution is nearly linear up to a load of 8 tons, the elastic stress in the tension reinforcement being then about 37,000 lb. per square inch. It should be pointed out that the steel strain measurements were made over 8in. and that in consequence the stress deduced from the observed strains is more in the nature of a mean stress over the 8in. gauge length, the stress in the vicinity of the crack being greater than that elsewhere.

After the concrete has visibly cracked in tension an irregularity in the strain distribution curves is observed for all the beams, this being accompanied by a rise in the position of the neutral axis. As the loading increases the neutral axis continues to rise until at high loads it attains a somewhat steady position at or near the theoretical position, excluding the tension in the concrete. An examination of the form of the strain distribution lines in a large number of graphs shows that the irregularity is more pronounced in some beams than in others and that it is often not possible to say whether the lines are concave or convex to the neutral axis. Generally, however, the strain curves above the neutral axis are convex to the axis, while those below the axis are sensibly linear. Goldbeck[2] found from his experiments on rectangular beams that the strain curves are approximately straight lines with a tendency to

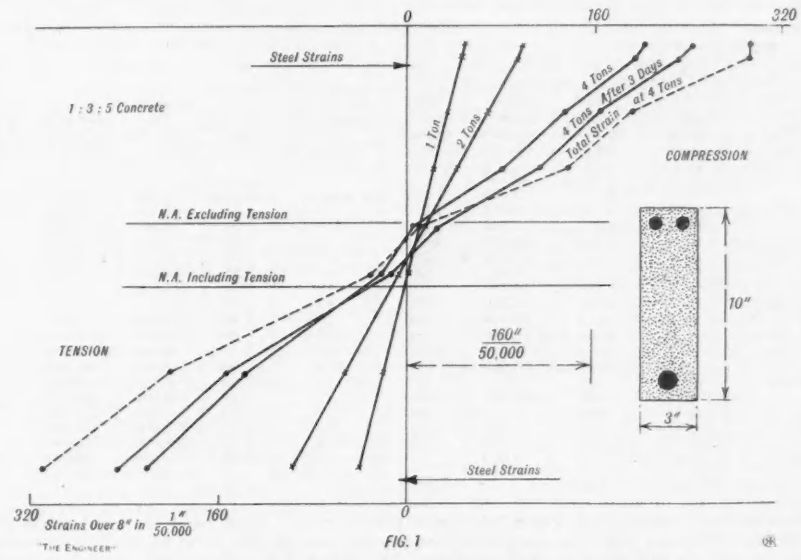
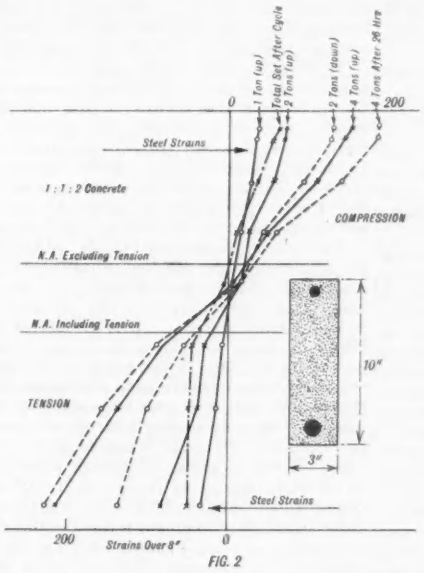
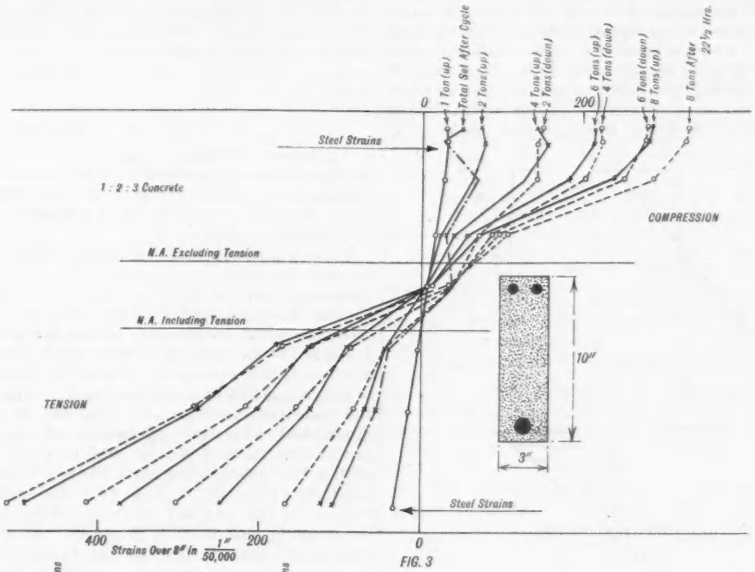
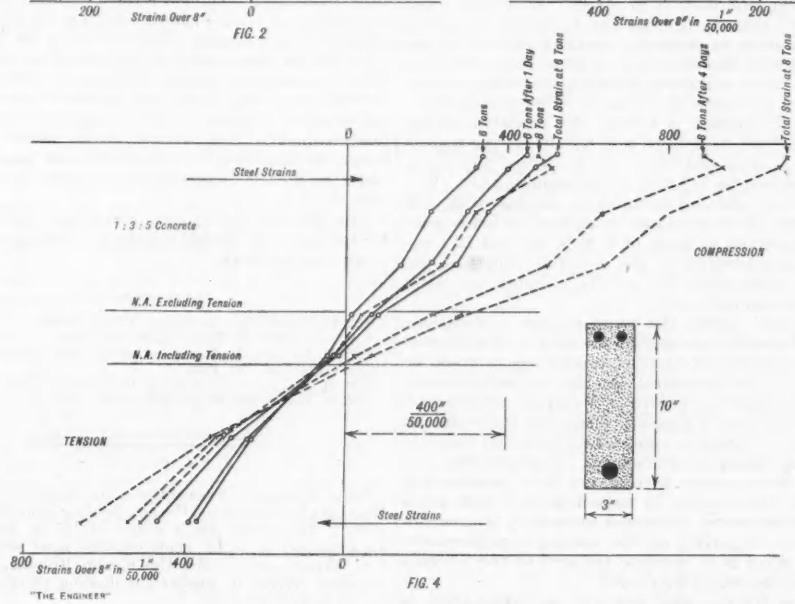
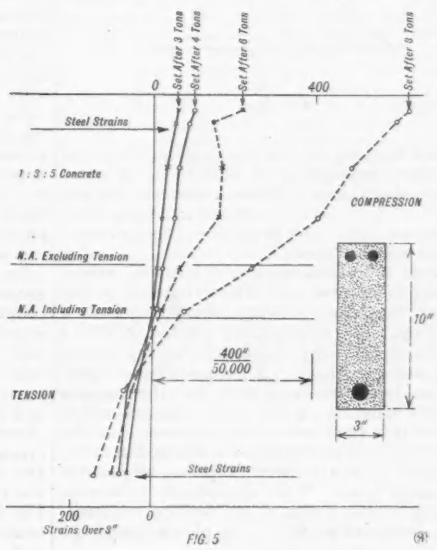


FIG. 1—STRAIN DISTRIBUTION IN 1 : 3 : 5 CONCRETE BEAM









FIGS. 2 TO 5—STRAIN DISTRIBUTION IN BEAMS OF VARIOUS COMPOSITIONS

become concave upward above the neutral axis and concave below as the loading progresses.

A peculiarity in some of the diagrams is that there is a kink in the strain curves at the level of the compression steel, the concrete strain just above the level of the compression steel being often less than the steel strain. This is contrary to expectations, and is due to the fact that the strain in the compression reinforcement was measured by exposing the steel at two points in order to receive the points of the extensometer. Photo-elastic experiments on celluloid beams show that the stress in the vicinity of the holes and in between the holes is modified by their presence, the modification depending upon the size and form of the holes.

Considering next the distribution of strain under sustained and cyclical loading, Figs. 1 and 2 show the effect of sustained working loads on the strain lines for concrete mixes of 1 : 3 : 5 and 1 : 1 : 2 respectively. The form of the lines remains sensibly the same as for the same loading before sustention, but the amount of creep in the compression zone of the beam is generally greatly in excess of that in the tension zone. This effect is more pronounced in doubly reinforced beams than in singly reinforced beams, and it is usually accompanied by a fall in the position of the neutral axis. The fall becomes more pronounced with increase of load, the fall in Fig. 3 under a load of 8 tons being appreciably greater than in Figs. 1 and 2 under a load of 4 tons. Similar results have been obtained by Richart, Brown and Taylor[3] when investigating the effect of plastic flow in rigid frames of reinforced concrete. Their results show that the most important effect of time yield is to produce very high stresses in compression reinforcement and large increases in the deflections, the ratio of final to initial values of these quantities ranging from 3 to 6. The observed increase in tensile steel stress, however, was relatively low, the average ratio of final to initial stress being 1 : 8.

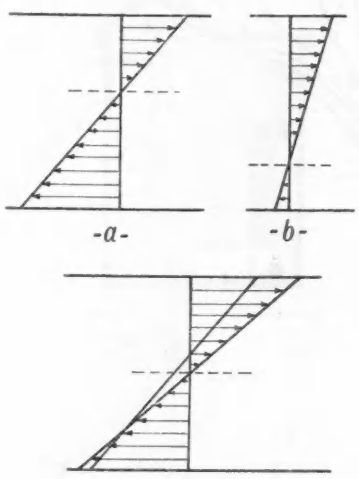


FIG. 6

With regard to cyclical loading it is characteristic of the strain in natural and artificial stones to lag behind when the stress is being reduced to form a hysteresis loop. The observations plotted in Fig. 3 show that the strains with decreasing loads lag behind those with increasing loads. A feature at the higher loads is the hysteresis exhibited by the tension reinforcement when so little creep appears under sustained loads in the tension reinforcement. At the higher loads the concrete in tension is cracked in many places and consequently little creep can be possible in the tension zone. The appreciable hysteresis characteristic of the strain in the tension reinforcement must be therefore due to the plastic properties of the concrete in the compression zone.

The total set strain curves in Fig. 5 cut the vertical line of reference at decreasing heights as the load increases. There is more creep in the compression zone than in the tension zone and it will be shown later that one would expect the position of the neutral axis to fall with the appearance of creep at the higher loads. The presence of compression steel will naturally tend to diminish the creep and to assist the concrete to recover in the compression zone. The assistance afforded by the compression steel to the concrete in recovering is illustrated in Fig. 5 by the set curve for the sustained load of 6 tons. Another interesting feature exhibited in Figs. 4 and 5 is the influence of excessive compressive stresses on the creep and total set strain lines. The compression steel in Figs. 4 and 5 consists of two $\frac{3}{8}$in. diameter mild steel rods, the yield stress of which varied from 40,000 lb. to 45,000 lb. per square inch. The compressive steel stress corresponding to the total strain at a load of 6 tons is 35,000 lb. per square inch, and it is very probable that the steel would yield under a load of about 7 tons. This does not apply to the tension reinforcement as this consisted of a $\frac{3}{32}$in. diameter steel rod having a yield point of 35 tons per square inch. Consequently, when the load was increased to 8 tons, as in Figs. 4 and 5, the compression steel would yield with the result that more of the compressive force would be transferred to the concrete in that zone. This would naturally result in a considerable increase of creep as in Fig. 4 with a considerable increase of permanent set as in Fig. 5.

TABLE I.

1	2	3	4	5	6	7	8	9	10
Remarks.	Range of load (tons).	Actual Depth to N.A. (in.).	Total compression (lb.).	Total tension in concrete (lb.).	Max. tensile stress in concrete to balance, lb. per sq. in.	Moment arm (in.).	Moment of resistance (lb.-in.).	Bending moment (lb.-in.).	E for concrete (1×10^6 lb. per sq. in.).
	0– 1	5·3	2,650	1,320	184	6·97	18,500	18,700	2·8
	0– 2	4·9	5,300	1,500	197	6·98	37,100	37,400	2·7
	0– 3	4·7	7,690	1,660	210	7·24	55,800	56,100	2·7
	0– 4	4·5	10,400	1,240	76	7·22	75,000	74,800	2·6
65 hours' creep ...	0– 4	4·9	10,660	1,320	87	7·00	74,700	74,800	1·7
	0– 5	4·5	13,210	1,660	101	7·23	95,500	93,500	2·6
	0– 6	4·45	15,520	770	49	7·34	113,800	112,200	2·5
18½ hours' creep ...	0– 6	4·65	15,720	770	49	7·25	113,800	112,200	2·10
	0– 7	4·45	18,300	500	29	7·42	135,800	131,000	2·65
	0– 8	4·40	19,650	360	22	7·49	147,400	149,600	2·4
26 hours' creep ...	0– 8	4·65	20,220	230	13	7·37	149,000	149,600	2·0
	0– 9	4·40	22,600	300	18	7·44	168,000	168,300	2·35
17 hours' creep ...	0– 9	4·55	22,750	180	11	7·40	168,000	168,300	2·06
	0–10	4·40	26,150	210	12	7·44	194,000	187,000	2·28
	0–11	4·45	26,730	190	11	7·76	207,000	205,700	2·22
66 hours' creep ...	0–11	4·75	28,530	90	5	7·38	210,000	205,700	1·53
	0–12	4·50	30,200	260	15	7·41	224,000	224,400	2·20
24 hours' creep ...	0–12	4·70	31,020	120	7	7·37	223,500	224,400	1·80

DISCUSSION OF RESULTS.

As the author has indicated[1, 5] information about the behaviour of reinforced concrete beams may be obtained by endeavouring to balance the internal forces such that the moment of resistance is equal to the bending moment.

Table I gives typical results obtained in balancing the internal forces for a doubly reinforced rectangular concrete beam of 1 : 2 : 3 mix. An inspection of column 6 shows that the maximum concrete tensile stress required to produce a balance at a load of 1 ton is 184 lb. per square inch, while the calculated concrete tensile stress according to the ordinary theory of bending is 265 lb. per square inch. This shows that the assistance given by the concrete in tension has diminished with the appearance of tension cracks in the concrete and a suitable illumination, together with a 10–1 magnifying glass, always enabled one to locate the presence of these very fine cracks when a balance of the internal forces could not be obtained for a linear distribution of stress. It is seen from column 10 that as the loading increases the value of the modulus of elasticity required to balance the internal forces diminishes, and that, when creep is included under sustained loading, the value of the modulus is considerably reduced. Thus the modulus necessary to produce a balance for repeated strains from zero load to 4 tons is $2{\cdot}6 \times 10^6$ lb. per square inch, and, after sixty-five hours' creep, the value has diminished to $1{\cdot}7 \times 10^6$ lb. per square inch. This reduction of the value of the modulus with the appearance of creep under sustention of loads may be also observed at loads of 6, 8, 9, 11, and 12 tons. These characteristics in the required values of the modulus agree with the results obtained on plain concrete columns.[4]

In Table I again, the moment arm calculations given in column 7 show that the arm of the internal couple increases with increase of load. This would be expected, since the neutral axis rises under increasing load such that the centre of concrete compression must rise to give a higher position for the resultant centre of compression considering both the concrete and compression reinforcement. Furthermore, one observes from column 6 that very little assistance is given by the concrete in tension at the high loads and that the centre of tension ultimately approaches the centre of gravity of the tension reinforcement. The net effect is to increase the arm of the internal couple as the load is increased.

Another feature that requires an explanation is the fall of the position of the neutral axis under sustained loads. This unusual behaviour may be explained in two ways. In the first, it should be borne in mind that the total compression or total tension in a beam does not change appreciably under sustained loads as the value of the modulus of elasticity of the concrete has to be reduced in order to effect a balance. Since very little assistance is afforded by the concrete when the beam is cracked the concrete in tension can creep very little under sustained stress. The concrete in compression, on the other hand, creeps appreciably. This state of affairs can be now considered to be produced by a horizontal force acting at some point in the compression zone, the object of applying such an imaginary excentric load on the section being to produce appreciable compressive strains in the compression zone and low tensile strains in the tension zone. For any section of the beam this imaginary force has to be applied outside the middle third points of the section, and it therefore produces slight tensile strains in the bottom fibres of the beam as illustrated in Fig. 6 *b*. The strains due to the ordinary bending forces are illustrated in Fig. 6 *a*, so that by combining Figs. 6 *a* and 6 *b* we obtain the resultant strains in Fig. 6 *c* after the appearance of creep. The reinforcement does not creep, but is compelled to move with the concrete in virtue of the adhesion between the steel and concrete. It thus follows from this explanation that the creep which appears under sustained loadings in the tension reinforcement and in the lower concrete fibres, when the beam is badly cracked in tension, is not direct creep, but indirect creep due to the creep appearing in the compression zone. It also follows that the amount of creep in both the tension and compression areas would be reduced with increase in the percentage of compression reinforcement.

In the second method attention is devoted to the moment of resistance of the internal forces. When the concrete is badly cracked a balance of the internal forces may be effected by maintaining the moment arm sensibly constant. If, then, under sustained loads some appreciable creep occurs on the compression side, since the centre of tension coincides with the centre of gravity of the tension reinforcement, it is necessary to lower the centre of compression of the concrete in compression in order to counterbalance the increased force in the compression reinforcement due to the transfer of stress during the appearance of creep from the concrete to the compression reinforcement. This can only be accomplished by lowering the neutral axis such that the resultant centre of compression, considering the compression reinforcement and the concrete in compression, remains at sensibly the same height.

The position of the neutral axis in doubly reinforced concrete beams may be determined approximately by measuring the strains in the compression and tension reinforcement and by assuming the strain distribution between these two points to be linear. In doubly reinforced beams the method sometimes gives too high a position for the axis and sometimes too low a position. In general, the method is sufficiently accurate for all practical purposes.

The most significant result obtained in this investigation is the marked influence of creep on the magnitude of the observed strains in the compression zone, and particularly on the strain in the compression reinforcement. The results show that the effect of creep on the steel stress is considerably greater in the case of the compression reinforcement than in the case of the tension reinforcement. Calculations show that it is always possible to balance the internal forces in doubly reinforced concrete beams, the influence of creep being to lower the required value of the modulus of elasticity of the concrete. A complete record of the stress in the compression reinforcement indicates that for small loads the total stress in the reinforcement is less than that calculated, excluding the assistance afforded by the concrete in tension. At working loads the total stress, which includes the permanent stress as well as the elastic stress, is usually greater than that estimated, the excess depending upon the interval the load is sustained and upon the percentage of compression reinforcement. The elastic stress under working loads, as obtained by repeating the load several times, is, however, somewhat less than the estimated stress.

The author wishes to express his gratitude to Professor W. T. David for the facilities provided to carry out this work.

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[2] A. T. Goldbeck, "Proc.," A.S.T.M., 1910.
[3] F. E. Richart, R. L. Brown, and T. G. Taylor, "Proc.," Amer. Conc. Inst., 30, 1934.
[4] R. H. Evans, "Proc.," Leeds Phil. and Lit. Soc., III, 1935.
[5] R. H. Evans, *The Struct. Engineer*, 14, 1935.

NEW WHALING FACTORIES.—The Deutsche Werf at Hamburg has completed the new floating refinery "Walter Rau." This vessel has a length of 175 m. and will be accompanied by eight whale catchers next season. The A.G. Weser yard of the Deschimag, Bremen, has completed a 30,000-ton deadweight floating refinery, said to be the largest yet built.

Rail and Road.

SOUTHERN RAILWAY BOAT TRAIN DERAILMENT.—On Sunday, September 19th, the 12.30 p.m. Southern Railway Company boat train from Dover to Victoria was delayed for three hours when the tender was partly derailed just outside Brixton Station.

A FRENCH ELECTRIFICATION SCHEME ABANDONED.—It is announced that the French Eastern Railway has decided not to proceed further with the proposed electrification of its secondary suburban line from the Place de la Bastille in Paris to Vincennes and Verneuil-L'Etang. A system of motor buses is to take the place of the present steam train service.

"THE RAILWAY HANDBOOK, 1937–38."—All those who are interested in railways will welcome the recent publication of the "Railway Handbook for 1937–38." As in previous years, the fourth edition of this little book, which is published by the *Railway Magazine*, contains a mass of up-to-date information and statistics. It deals mainly with the railways of this country.

AN IRISH TRAIN SERVICE TO CEASE.—The service of trains on the Westport to Achill branch line of the Great Southern Railways of Ireland will cease to run on October 1st. A motor bus service is to be opened for passengers, and motor lorries are to be provided for the carriage of merchandise. Depots for handling goods are to be established at Mallaranny and Achill.

NEW BRIDGE OVER THE MISSISSIPPI.—Work has begun on the Baton Range Bridge over the Mississippi River. Costing over 8 million dollars, the bridge will include two cantilever spans with a horizontal clearance of 848ft. each, and vertical clearances of 65ft. The main structure will be 3326ft. long, and the approaches 8900ft. long. It will carry a single-track railway and two 18ft. wide roadways.

RAILWAY ELECTRIFICATION IN SOUTH AFRICA.—The whole of the main line railway in Natal between Durban and Volksrust, a distance of 321 miles, has been electrified. Steam working on the 77 miles section between Glencoe Junction and Volksrust has been superseded by electric traction. This electrification will reduce the running time between Durban and Johannesburg by at least half an hour.

AMERICAN RAILWAY'S INCOMES.—During the first six months of this year the Class I railways of the United States reported a net income, after fixed and contingent charges, of over 36 million dollars, as compared with a deficit of over 23 million dollars for the corresponding period of 1936. Seventy-five of the railways reported net incomes and fifty-eight reported deficits to the Interstate Commerce Commission.

RECONDITIONED FISH-PLATES.—According to a note in the *Railway Gazette*, the Victorian Government Railways are getting very satisfactory results from reconditioned fish-plates. In the reconditioning method used, 4in. long pieces of spring steel of various thicknesses are welded on to the top of the fish-plate, and their outer ends ground to form a taper. It is stated that by this means rail life is increased, maintenance expenditure reduced, and running improved.

RAILWAYS IN SWEDEN.—The Inland Railway of Sweden is now practically complete. This line, which runs from the northern end of Lake Vänern, in Central Sweden, through nearly 1000 miles of sparsely populated country to Gellivare, in Lappland, is generally regarded as the last link in the country's railway system. It is improbable that the railway will ever pay, but it has been built for military reasons, owing to the vulnerability of the main line along the coast. It has cost about 135 million kroner, and taken nearly thirty years to build.

L.N.E.R. TRAIN MISHAP.—On Saturday, September 18th, when the London and North-Eastern Railway Company's 10.35 p.m. train from London to Edinburgh was being held up by signals east of Joppa Station, it was run into by a passenger train from Musselburgh to Edinburgh. The London train was about to start, after having been checked by signals, when the other train drawing into the station crashed into the rear of it. The guard of the London train was slightly hurt, and several passengers bruised, but there were no serious injuries.

THE NEW G.W.R. BRANCH LINE AT LOOE.—Work has begun on the first section of the new Great Western Railway branch line between Looe and St. Germans. In building the line two viaducts, one at Millendreath, about 735ft. long, and the other at Keveral, about 840ft. long, will be constructed. The line also involves the construction of two tunnels, 700 yards and 2288 yards long respectively. Stations are to be built at Looe, Millendreath, and Downderry. Work is at present in hand on a 4-mile long section between Looe and Keveral.

LONG AMERICAN BRIDGE.—One of the largest highway bridges in the south of the United States is now being built over the Neches River, near Port Arthur, in Texas. Although the river is only 1000ft. wide, the bridge will be 7700ft. long, as a result of the long approaches required at either side of the 400ft. wide navigation channel, the clearance over which is 176ft. The approaches to the 680ft. wide centre span pass over a considerable area of marshy ground. As a result of the bridge being in the hurricane area, it is designed for the unusually heavy wind load of 75 lb. per square foot.

CINEMATOGRAPH FILM UNITS ON THE L.M.S.—In readiness for the 1937–38 season, the London, Midland and Scottish Railway Company has built a third travelling film unit. A production programme, involving five new talking films, is also nearing completion, and these will be exhibited by the travelling units. The company's film activities are concerned first with educational films, which, embracing railway activities in general, are shown to both the staff and traders, and, secondly, with instructional films exhibited solely to the staff. The former are general interest films depicting various parts of railway operation, while the latter aim at conveying to the widely scattered staff, not only the right and wrong way of working, but hints upon the best way in which to perform their duties.

Miscellanea.

BIG CANADIAN POWER PLANT.—An immediate start is to be made on the construction of a 1,000,000-dollar power plant at the mouth of the Montreal River to develop 10,000 H.P., it has been announced by the Ontario Minister of Lands and Forests. Work is to be completed within twenty months, according to the Government's arrangement with the Great Lakes Power Company, Ltd.

STEEL OUTPUT IN SHEFFIELD.—During the first six months of this year the Sheffield district produced a total of 853,100 tons of steel ingots and castings, 68,800 tons more than the corresponding period last year. The highest month's production was during March, when the total was 150,900 tons, the highest yet recorded. In view of the extensions and modernisation proceeding at several works, it is expected that output will steadily increase as the year proceeds. The present demand for steel in the district is such that new orders are no longer being sought.

COKE-OVEN BY-PRODUCTS.—The *Board of Trade Journal* publishes preliminary figures obtained under the Fifth Census of Production (1935) in connection with the coke and by-products trade of the United Kingdom. It shows that during 1935 the total output of metallurgical coke was 12·4 million tons. Other by-products produced were as follows:—Crude coal tar, 470,000 tons; refined coal tar, 72,000 tons; pitch, 95,000 tons; sulphate of ammonia, 161,000 tons. The quantity of crude benzole produced by firms making returns on schedules for the trade totalled 19,648,000 gallons, and refined benzole 26,988,000 gallons.

"DRY ICE" FOR EXTRACTING LARGE SHAFTS.—"Dry ice" is now being used extensively for assembling and dismantling shrunk fits, and *Power Plant Engineering* describes a large job of this kind carried out at the Queenstown hydro-electric station at Niagara Falls. A 40-ton steel shaft was extracted from a 270-ton rotor by cooling the shaft with a mixture of dry ice and alcohol. The freezing mixture, consisting of 350 gallons of alcohol and 3 tons of dry ice, was placed in a tank and the mixture pumped through the hollow shaft. The shaft, which was some 30ft. long, was completely free of the rotor in about two hours, and the mixture reached a temperature of — 97 deg. Fah.

GENERATION OF ELECTRICITY.—The Official Returns rendered to the Electricity Commissioners show that 1529 million units of electricity were generated by authorised undertakers in Great Britain during the month of August, 1937, as compared with the revised figure of 1332 million units in the corresponding month of 1936, representing an increase of 197 million units, or 14·8 per cent. The number of working days in the month (*i.e.*, excluding Sundays and Bank Holiday) was twenty-five, the same as last year. During the first eight months of 1937 up to the end of August, the total amount of electricity generated by authorised undertakers was 14,339 million units, as compared with the revised figure of 12,627 million units for the corresponding period of 1936, an increase of 1712 million units.

ACTIVATED CARBON.—In connection with the use of activated carbon in water and sewage work, the American correspondent of the *Contract Journal* has written to it as follows:—"Activated carbon applied for about four months to the Ithaca, N.Y., digestion tank and for several weeks to experimental digesters, indicated that when added to fresh sludge it reduces odour, increases the methane content of the gas produced, increases the drainability of the sludge (the maximum influence being when the carbon is added at the rate of 30 p.p.m.), and increases the temperature of the sludge when less than 5 p.p.m. is added. Addition of 5 to 15 p.p.m. of carbon appeared to increase the gas yield at 20 deg. Cent., but not at 28 deg., but to reduce it when added in greater amounts. Addition at 20 deg. Cent. hastened completed digestion, but not at 28 deg. and 45 deg.

FUSIBLE ALLOYS CONTAINING TIN.—A number of applications of fusible alloys are described by E. J. Daniels in a new technical publication of the International Tin Research and Development Council. The booklet is devoted to considering the bearing of composition upon the melting point and the structure and physical properties of the fusible alloys. It also describes their applications and gives a number of references to published literature on the subject. It is shown that Wood's metal, Lipowitz's alloy, and other well-known compositions are extremely close approximations to the eutectic mixtures of phases consisting of either pure metals, solid solutions or one metal in another or intermetallic compounds. It is important to cast the alloys under controlled conditions to get dependable results, in regard to plasticity and creep. The solidification of many of these alloys is accompanied by expansion instead of contraction, because they contain bismuth or antimony. Amongst the applications given are sprinkler plugs, boiler plugs, fusible links, seals for glass apparatus, patterns for moulding and electroplating, tube bending, tempering baths, and die mounting.

LIGHT ABSORPTION BY DIRTY GLASS.—In the course of his Presidential Address before the Association of Public Lighting Engineers, Mr. C. I. Winstone described a test he made to ascertain the absorption of light by dirty glass on street lighting apparatus. Eight pieces of 21 oz. flat clear glass, 12in. square, were fitted in a frame 8ft. long and fixed vertically 16ft. above ground well away from buildings. At the end of every two weeks one piece of glass was removed and placed in an air-tight box. This was done until seven pieces were taken down, and the eighth piece was left for a further three weeks. They were then tested, piece by piece, for absorption caused by the dirt from the atmosphere, with the following results:—Glass No. 0, clean, 9·5 per cent.; glass No. 1, exposed two weeks, 11 per cent.; glass No. 2, exposed four weeks, 11·2 per cent.; glass No. 3, exposed six weeks, 12·2 per cent.; glass No. 4, exposed eight weeks, 12·6 per cent.; glass No. 5, exposed ten weeks, 13·4 per cent.; glass No. 6, exposed twelve weeks, 16·6 per cent.; glass No. 7, exposed fourteen weeks, 17·5 per cent.; glass No. 8, exposed seventeen weeks, 18·2 per cent.

Air and Water.

SINGING PROPELLERS.—Mr. Harry Hunter has been awarded the gold medal of the North-East Coast Institution of Engineers and Shipbuilders for his paper on "Singing Propellers." This paper was reprinted in THE ENGINEER of February 26th and March 5th this year.

THE PROPOSED FLORIDA SHIP CANAL.—Particulars of the proposed ship canal through the State of Florida, connecting the Atlantic with the Gulf of Mexico, were recently given to *Lloyds List* by Mr. H. H. Buckman. The new canal will cost about 200 million dollars to build and will be 187 miles long, but by utilising two rivers actual excavations will only be 31 miles long. It will have a minimum width at the bottom of 400ft. and by means of floodlighting it will be kept open to traffic at night.

NEW ARGENTINE DESTROYERS.—On Tuesday, September 21st, the three torpedo-boat destroyers being built for the Argentine Government by Vickers-Armstrongs, Ltd., were launched at Barrow. The three ships were named "Buenos Aires," "Corrientes," and "Entre Rios," after provinces in the Argentine. Four similar ships are being built for the Argentine Government, two by John Brown and Co., Ltd., and two by Cammell Laird and Co., Ltd. The armament for all seven ships is being supplied by Vickers-Armstrongs, Ltd.

LLOYDS REGISTER WRECK RETURNS.—The recently issued wreck returns show that during the quarter ended March 31st last the number and gross tonnage of ships of 100 tons gross and over totally lost were as follows:—Great Britain and Ireland, twenty-three ships of 19,850 gross tons; other countries, sixty-one ships of 94,518 gross tons; making a total of eighty-four ships of 114,368 gross tons. Ships broken up, condemned, &c., not known to be in consequence of casualty or stress of weather totalled 126 of 182,559 gross tons.

LARGE AMERICAN WATER PROJECT.—After a considerable amount of litigation it has been decided to proceed with a water power and navigation project costing over thirty-seven million dollars in South Carolina, in the United States. The scheme involves the deepening of the Cooper River and improving Charleston Harbour, into which the river flows, with a view to reviving water transportation between Charleston and Columbia. Two dams will be built to develop power and divert water from the Santee River into the nearby Cooper River. The Santee dam will create a lake about 35 miles long and supply water for the power plant, while the other dam will further control the flow in the proposed canal and diversion of water into the Cooper River.

GERMAN INLAND WATERWAYS.—During the next ten years it is planned to spend 1200 million marks on inland waterways developments in Germany. The Adolf Hitler Canal, which replaces the old Clodnitz Canal, will be opened in 1939. According to *Shipbuilding and Shipping Record*, the Mittelland Canal will be completed to Magdeburg by 1939, and three years later the Thuringian storage basins and the Saale-Elster-Leipzig connection will be completed. The Masurian Canal in East Prussia is to be finished by 1942. Other works to be completed within the next few years are the enlargement of the Dortmund-Ems Canal for 1500-ton vessels, the regulation of the Rhine between Strassburg and Basel, and the canalisation of the Main and Neckar for the Rhine-Danube connections.

THE ENGLAND TO INDIA MARINE AIR ROUTE.—One of Imperial Airways' new flying boats, the "Ceres," has just completed a flight over the new marine air route to Karachi, testing the organisation which has been provided for flying-boat operation between Egypt and India. Onward across India, from Karachi to Calcutta, the marine air line will go *viâ* Udaipur, Gwalior, and Allahabad to Calcutta. A lake at Raj Samand, in Udaipur State, and a stretch of water at Gwalior, will provide alighting points. At Allahabad a stretch of river will be employed, while at Calcutta the flying boats will operate to and from a stretch of river within the confines of the seaport. Farther eastward, along the air route, the organisation will include the harbour at Singapore, while preparations are actively in hand in Australia to provide alighting points and equipment for the flying boats.

A NEW MOTOR-DRIVEN OIL TANKER.—The M.V. "British Integrity," the fourth of eight similar motor-driven oil tankers ordered from Harland and Wolff, Ltd., by the Anglo-Iranian Oil Company through its subsidiary, the British Tanker Company, Ltd., after having completed a satisfactory trial trip, has been handed over to her owners. Two sister ships, the "British Power" and the "British Destiny," are already in the company's service, while the third, the "Boardale," was recently transferred to the Admiralty on her completion for service as a Royal Fleet auxiliary. Like her sister ships, the "British Integrity" has been specially designed for the carriage of petroleum in bulk, and is propelled by Harland-B. and W. six-cylinder, four-stroke, single-acting oil engines with airless injection and pressure induction. It is of interest to record that engines of the Harland-B. and W. type have been fitted to over 900 vessels, representing almost five million B.H.P.

ISLE OF MAN AIR SERVICES, LTD.—Further to our notice last week in connection with the Isle of Man Air Services, Ltd., we have been informed by the London, Midland, and Scottish Railway Company that it has nominated Mr. W. P. Bradbury and Wing Commander A. H. Measures to the board of the former company. The Isle of Man Steam Packet Company will be represented by Sir Frederick Clucas and Mr. C. S. Edgar, and Captain C. P. Olley and Mr. J. W. S. Comber will retain their directorships of the Isle of Man Air Services. The chairman will be Mr. W. P. Bradbury, who is assistant (Passenger) to the chief commercial manager, L.M.S. Railway; Mr. R. L. Carter has been appointed general manager, with headquarters at Isle of Man airport. Railway ticket agents are being authorised to accept bookings for Isle of Man Air Services, Ltd., and the passengers utilising the services of this company will enjoy the special luggage in advance and ticket inter-availability arrangements available to passengers by Railway Air Services.

VIEWS IN WORKS VISITED BY THE IRON AND STEEL INSTITUTE

(For description see page 342.)

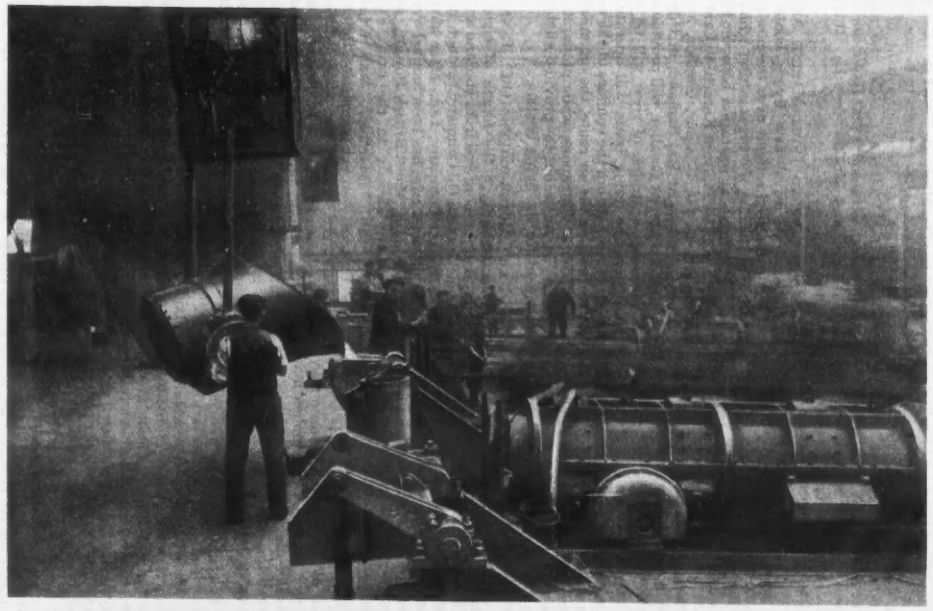

FIG. 1—CENTRIFUGAL PIPE CASTING MACHINES—COCHRANES

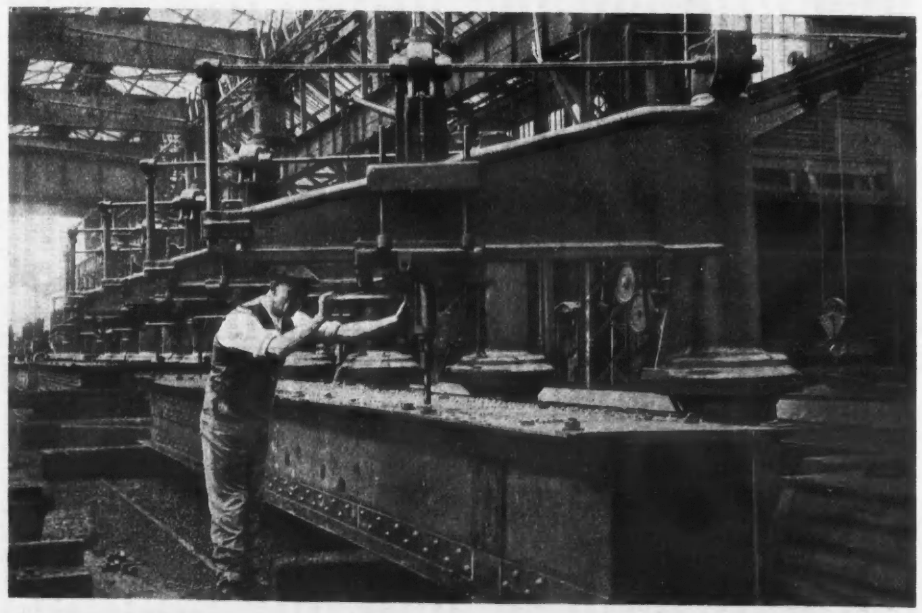

FIG. 2—RANGE OF DRILLING MACHINES—CLEVELAND

FIG. 3—18-INCH ROLLING MILL—SKINNINGROVE

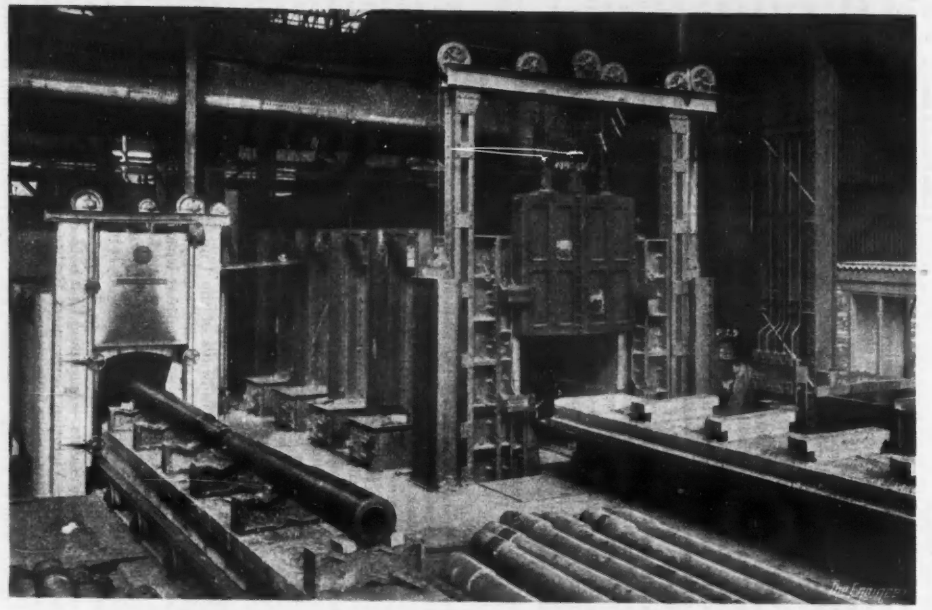

FIG. 4—HEAT TREATMENT FURNACES—DARLINGTON FORGE

The Engineer

SEPTEMBER 24, 1937.

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NOTICES TO READERS.

**** If any Subscriber abroad should receive* THE ENGINEER *in an imperfect or mutilated condition, he will oblige by giving prompt information of the fact to the Publisher, with the name of the Agent through whom the paper is obtained. Such inconvenience, if suffered, can be remedied by obtaining the paper direct from this office.*

**** For Subscription rates, see page 2 of Advertisements.*

**** All letters intended for insertion in* THE ENGINEER *or containing questions should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

**** No undertaking can be given to return drawings or manuscripts; correspondents are therefore requested to keep copies.*

CHANGES OF ADDRESS.

**** Will subscribers please note that in all advices regarding changes of address it is necessary to have* **both the old and new addresses,** *as our lists are kept alphabetically by towns. Advices of this nature should reach us by the first post Wednesday morning prior to the alteration.*

HOLIDAYS AND SHORT HOURS.

IT is to be feared that many of the people who talk, and, still worse, write about, short hours and holidays have not considered all the implications of those two sociological changes. On the face, it looks the easiest thing in the world to say every man shall have two weeks' holiday with pay and that no one shall work more than forty or forty-five hours a week. Moreover, it seems equitable that the workman should be treated just like the salarian, whose monthly cheque is entered to his account when he is away on vacation; and it seems rational to conclude that the reduction of the number of working hours must be met by an increase in the number of people employed. Unfortunately, things do not work out so easily as all that. The comparison between salarians with their more or less indefinite hours, and workpeople, with quite definite hours, is by no means equitable, whilst as regards the forty-hour week we have now the evidence of France that the universal application of it is well-nigh impossible, and that, as we anticipated long ago, it is not causing any increase in the amount of employment. On Sunday last, Monsieur Chautemps, the Prime Minister of France, suggested that a change would have to be made. At the same time that the forty-hour week has failed to solve the problem of unemployment, it has delayed output and is raising the price level despite efforts to restrain that effect.

Apart from the economic questions which are raised by these two innovations—paid holidays and short hours—there are very human problems which demand consideration. Under an individualistic regime, it was possible to devise regulations of such a flexible nature that each man could accommodate himself to them. But nowadays when all regulations tend to become national and compulsory, everyone has to be treated in exactly the same manner, whatever his personal predilections may be. In the present case if the law requires that every wage earner shall have a fortnight's holiday with pay, then every such person will have to cease work for the prescribed time, whether he wishes or no. It so happens that many workers, probably quite an appreciable minority, do not want to take holidays. For one reason or another, frequently of a domestic nature, they would rather remain at work. A holiday to the workman, means frequently sitting at home in his shirt sleeves. That can become an exceedingly boring occupation, and even worse than boring if the home conditions are not of the best. Hence it has been observed that workmen on holiday seek work—and pay—elsewhere. A familiar picture is that of two factories A and B which give holidays simultaneously, and are in consequence short-handed. All that happens is that the men from factory A go to factory B and those from B go to A. That is, of course, entirely against the spirit of the regulation and against the spirit of industrial legislation, which demands that all men shall do what they are told, and do it alike. Moreover, it defeats one of the supposed advantages of holidays—that they are good for the health. Hence, some means of absolutely preventing men from occupying themselves for pay during their holidays has to be found. A mechanic, for example, must be prohibited from doing a hand's turn at jobbing gardening, though that might be a far better holiday for him than kicking his heels "amongst the kids" in a mean street. The alternative is to give men an optional holiday, and that may prove to be the most practicable course. That is to say, they would receive at any time during the year two weeks' extra pay and they could please themselves as to the use they made of it. In the North the wake and fair holidays, extending over a week, already exist, and it is more than probable that the workers would be better satisfied with a few extra pounds to spend at those times than be compelled to idle at other times, which would have to be allotted by the management. In a sense, the forty-hour week is a miniature of the paid-for holiday. It means that the workers get away an hour earlier each day. It might be supposed that they would all like that; but that is not so. We had a few days ago the evidence of a very large factory employing many girls. Occasionally it happens that work is slack and the girls are told that they can go off for the afternoon. But there is always a good proportion that refuses to do so. The girls prefer to remain inside the factory gates than to return home, where they will be set to doing household chores by their mothers.

In indicating some of the difficulties which the holiday with pay and the forty-hour week present, we do not wish it to be assumed that we are opposed to these changes. As far as the short week is concerned, it is the natural and inevitable consequence of improved and accelerated methods and means of production. Hours of work have grown shorter and shorter as the machine has gradually taken over more and more of the work formerly done by hand. The reduction to forty and even thirty hours a week is bound to come. But, in our view, it is desirable that it should come slowly, so that, on the one hand, the workers and, on the other, the industries, may accommodate themselves to it. To make it compulsory for all industries without distinction has been found in France to be a grave mistake. It would be far better if each industry were left to make its own arrangements with its own labour. A common law for the whole land would be disastrous. The same may be said of the holiday with pay. Already many firms give a week or more with pay, and the principle will extend as naturally amongst the workers as it has amongst the staff. If to a hurrying age that is considered too slow, and if a national law should be the only thing that would satisfy Labour, then we suggest that it should be left as elastic as possible. We are convinced that the British factory worker—male or female—has no desire to be "regimented," and that in a personal matter like holidays he would prefer to make his own arrangements than be forced to follow a parliamentary regulation.

The Steel Export Markets.

A YEAR ago iron and steel export business developed a sudden activity, which continued for practically ten months without a break. The movement was almost explosive, so unexpectedly did it burst upon the markets. Previously there had been a period during which the Continental works were hard pressed to obtain orders to keep their mills occupied, and during which they had sought business with no great success from Great Britain. It is difficult to give a satisfactory reason for the movement; but war scares were rife, stocks were low and social legislation in Belgium and France made the outlook regarding costs uncertain. Probably with the market in this condition a little normal buying gave rise to a panic desire amongst foreign dealers to ensure supplies. As a result, from last September onwards there was an insistent demand for the principal iron and steel products from markets so far apart and so diversified in their requirements as China and the Argentine, and the Continental works extended the periods required for delivery from a few weeks to several months. Not since the European Steel Cartel was formed had the situation been so favourable for the producers, as sufficient progress had been made in the organisation of the markets to enable the Cartel to regulate its prices. The export situation had repercussions in the British home market, and with the advance in prices deliveries of Continental steel to Great Britain fell into arrears. It cannot be doubted that the more attractive prices obtained in the world's export markets were largely responsible for the neglect of British consumers by Continental makers, and so played an important part in creating the shortage of steel which has ruled in this country. Some idea of the increase in the Cartel's export trade can be gathered from the following figures. In 1936 the French monthly average iron and steel exports were 129,700 tons; Belgium and Luxemburg, 264,700 tons; and Germany, 296,400 tons. For the last three months of 1936, however, the average for France jumped to 144,800 tons and for the first five months of this year to 151,900 tons. For Belgium and Luxemburg the average for the last quarter of 1936 was 281,600 tons and for the first five months of this year 314,100 tons. The German figures, which were higher in the first place, do not show the same increase, being for the last three months of 1936 296,500 tons and for the first five months of this year 299,300 tons. The British exports of iron and steel averaged 186,400 tons per month in 1936, 200,300 per month in the last quarter of that year, and for the first five months of this year 225,200 tons.

Whilst the export demand was exhibiting this unusual strength, the Continental steel industries were not in a position to take full advantage of their opportunities. The French steel makers have had to adjust themselves to new financial and labour conditions. Germany has had to meet a home demand almost as strong as that which has ruled in this country and which has kept the British makers struggling to overtake arrears of deliveries on home as well as on export account. The works in Belgium and Luxemburg have been in the best position to exploit the situation, but the former were for a part of the year hampered by a shortage of raw materials. In these conditions it is perhaps not surprising that the prices of Continental steel products were raised again and again; but the wisdom of such a policy may be doubted. Bars and angles, which in September, 1936, were sold at £2 14s. 8d. to £3 15s. gold, f.o.b., are now quoted at £6 to £6 7s. 6d. gold, according to the market; whilst joists, which were £2 17s. 6d. to £3 15s. gold f.o.b., are now £5 7s. 6d. Plates $\frac{3}{8}$" basis, have advanced over the same period from £4 7s. 6d. f.o.b. to £7 2s. 6d. to £7 7s. 6d. gold, f.o.b. The increases in these prices, if converted into sterling, amount in the case of certain markets to as much as £5 10s. on bars and angles, £4 10s. on joists and £5 on plates. It is common knowledge that the Cartel's policy of raising prices to this extent did not meet with the British makers' approval. Protests, however, were unheeded and it must be admitted that although the British makers have raised their export prices on most materials, they have shown greater restraint than their Continental allies. Since September, 1936, the British export prices for bars, angles, and other structural material have been raised by £2 12s. 6d. sterling, the quotation for angles being £8 f.o.b. a year ago, against £10 12s. 6d. to-day. In the case of plates, $\frac{3}{4}$in. basis, the quotation in September last year was £8 5s. f.o.b., compared with £11 to-day. It was not until midsummer of this year that the export situation began to change. The Indian market was the first to show signs of being surfeited, and many dealers there endeavoured to cancel contracts they had entered into with Continental makers. The latter, however, refused to meet them except upon onerous terms, and since then that country has been gradually absorbing the steel bought so enthusiastically earlier in the year. More recently still practically all the export

markets have greatly curtailed their demands for steel.

It is impossible to say how far the high prices insisted upon by the Cartel have been responsible for the decline in the export trade. Even if the importers in various overseas markets were willing to pay the prices required, it did not follow that the consumers to whom they re-sold were equally amenable, and in the case of some markets there is no doubt that stocks have accumulated simply because internal buying became restricted as values were advanced. The hostilities in the Far East have had unfortunate repercussions in other Eastern markets, as Continental material *en route* to China and Japan has been diverted to the Dutch East Indies, the Philippines and other countries and has helped to disturb the world's trade. To some extent also India has been affected, but chiefly from the fear of what might happen if steel for China were unloaded in any quantity in that already congested market. It has been suggested that in the normal course the export demand for Continental steel should revive in the autumn, and there is still time for such a development. Against this must be set the fact that stocks have accumulated in some countries. The uncertainty felt regarding the future of the franc is another factor to be taken into account, since it might conceivably influence French prices. When the devaluation of the franc took place, however, the French steel makers maintained their Cartel price arrangements and will probably continue to do so. At the moment the Continental makers appear to be on the horns of a dilemma: to advance their prices would be absurd; to maintain them is difficult; and to reduce them might precipitate disagreeable consequences in more than one overseas steel market. The policy of making hay while the sun shines seems to have been somewhat recklessly followed, and there is a danger that if the promised revival in the export trade does not mature the Continent may be forced to make a difficult retrograde movement. The alternative is to maintain prices at their present high level until foreign purchases have been absorbed and this, too, may prove an unwelcome course. Experience has shown, however, that world conditions are susceptible to rapid changes, and any improvement in the international situation would probably bring about a revival in confidence which would be reflected in more active overseas buying. But there is no doubt that such a revival would need to be stimulated by a conservative and helpful price policy.

The British Association.

No. III.

(Continued from page 313, September 17th.)

Television.

THE first paper in Section G on Tuesday, September 7th, was by Professor E. W. Marchant, and dealt with "Electrical Vibrations and their Applications in Television." In it the author gave a description of the methods used for producing electrical vibrations of various kinds. The dynatron oscillator was illustrated by a water model with a valve having a controlling force which diminishes as the valve opens, and it was pointed out that such an arrangement, with a U tube connected across it, illustrates the principle of the action of this oscillator, the oscillation being demonstrated by the movement of the water in the U tube. The principle of the thyratron control "time base" for a cathode ray oscillograph or television receiver was also illustrated by a water model. The capacity of the condenser in the circuit giving the time base was represented by a small pivoted vessel, so arranged that when it fills it tilts over and empties itself. The flow of water into the vessel is kept constant, as is the electric current which charges the condenser used in the "time base," and the grid bias of the thyratron is represented by a pivoted arm which prevents the tilting over of the vessel until it has filled to a definite level. The height to which the vessel must fill before tilting over is controlled by a weight on the pivoted arm. The paper also explained the arrangements for focussing the photo-electric image, so as to produce the necessary photo-electric currents for television transmission, reference being also made to the need for using short waves and the corresponding limit of distance to which television transmissions can be sent.

Motor Vehicles and Road Safety.

Following the paper by Professor E. W. Marchant, Mr. L. H. Pomeroy (a Past-President of the Institution of Automobile Engineers) contributed a paper on the design of motor vehicles in the interests of traffic safety. Inasmuch as the pedestrian is required to exert but little intelligence to avoid a motoring accident, whilst the motorist is called upon to exercise consistently the highest degree of concentration and self-control, he considered the design features which reduce fatigue and aim at giving the feeling of confidence and control essential for dealing with emergencies. High speed *per se* he dissociated from danger, on the grounds that 15 m.p.h. in a crowded street may be more dangerous than 80 m.p.h. on an open road.

The highest reasonable average speed from point to point he regarded as being in the region of 40 m.p.h. for normal English road conditions. Ultra high speeds, in his view, are not essential, and average performances might be improved rather than otherwise by a maximum speed limit of 60 m.p.h. It is most unfortunate, he said, that maximum speed bulks so largely in publicity matter and in the minds of many designers. American motor car publicity makes virtually no reference to maximum speed, for the reason that with cars of high acceleration, it has been realised that maximum speed is a relatively unimportant matter. The American car has a great attraction, with its normal acceleration of some 4ft. per second per second on top gear, compared with an acceleration of some 2·7ft. per second per second on the typical popular British car. Given cars of high acceleration, no small part of the basic risk due to congestion would be eliminated, because of the much higher average speed and reduced number of cars on the road arising therefrom.

In urging his contention that car design is a problem in which body necessities must be settled first and the body made to suit, the author remarks that, unfortunately, car body designers are like architects in that not one in a hundred will sacrifice beauty to usefulness.

Commenting adversely on the modern streamline body, the author said that in this country the desire for lightness and for good appearance in small cars has tended to a design which has lopped off the corners of the rectangular prismatic form, and caused a sacrifice of comfort in the interests of appearance.

Dealing with chassis design, the author again drew attention to the importance of high acceleration and its inhibition in British engine design by horse-power and petrol taxation. Too much reliance has been placed, he said, upon gear-changing to obtain acceleration. It is by no means seldom that safety is a matter of a good clean acceleration at quite low speeds on top gear, when changing down would be useless. It should always be kept in mind by designers that acceleration is extremely sensitive to gradients. All cars have a limiting gradient which is climbable on top gear with zero acceleration. A slightly easier gradient turns no acceleration at all into acceleration, *i.e.*, a change measured by infinity. Thus a relatively small increase of acceleration produces an entirely disproportionate and very desirable sense of increase of performance.

Other matters dealt with were braking and springing, and their relation to steering and stability. The braking problem was presented in terms of the high duty required from brakes, and the author described the complex leverage problems of applying high retardations by the human foot and the means for assisting pedal action by self servo and external servo actions. Independent front springs, he said, have done more for the cause of good steering than anything else, for the reason that the gyroscopic effects of the rotating front wheels can be greatly reduced and in some designs eliminated.

Discussion.

Colonel Pickard remarked that the official statistics attributed very few accidents to vehicle defects, but in his view there were certain latent defects in vehicles which contributed to accidents much more than was generally realised. Among the most important of these were the driver's vision and the brakes. Many young and old people were injured or killed on the roads and the reason often given was that the driver did not see them in time. He wondered to what extent this was due to the driver not having a clear, unobstructed vision all round, coupled with efficient brakes.

Mr. Pomeroy said he had emphasised the importance of good visibility in the paper, and the chief offender was the blind spot on the right-hand side of the wind-screen. If the fixed windscreen was abandoned that blind spot would be reduced from 4in. to 2in., which would be a very great improvement.

Wing-Commander Cave-Browne-Cave said that among the chief causes of lack of vision was the radiator, but there was a reluctance on the part of designers to alter this. To provide a better view forward, however, it was necessary either to seat the driver higher or alter the radiator shape. The position was also very unsatisfactory in respect of the view behind. If the motor car designer had to do what the aircraft designer had to do, viz., make a three-dimensional graph of the area he could see and that which was blind, the position of affairs might be considerably improved.

Hardness Tester.

Mr. Edward G. Herbert, who followed with a paper on "A Continuous Hardness Test: Periodic Hardness Fluctuations," said it had long been known that metals which have been severely treated as by hammering or rolling, or by heating and cooling, are thereby placed in a state of instability which usually persists for many hours, or even for days and weeks. The evidence of instability or "ageing changes" is usually obtained by making hardness tests at frequent intervals of time.

To do this tedious work expeditiously the continuous hardness test was invented. In it the hardness changes are made to record themselves automatically and continuously. The specimen of metal is mounted in a carriage and traversed very slowly by clockwork while a stationary grooving tool loaded with a weight of 5 kilos. rests upon it. The groove so formed constitutes a permanent record of hardness changes, becoming deeper and wider when the hardness decreases, and shallower and narrower when the hardness increases. By "scanning" the groove, projecting it on the screen of a microscope under high magnification and measuring its width at close intervals, corresponding to minutes and hours marked on a time scale, it is possible to draw a graph of all the hardness changes which have occurred over a period of several days and nights.

A further difficulty had to be surmounted. A sharp grooving tool acts like a plough share, turning over the metal and depositing it in ridges on either side of the furrow, and in so doing it entirely alters the characteristics of the metal. This difficulty was dealt with by using a hard steel ball 1 mm. in diameter, mounted in a special socket in such a manner that it revolves as the metal moves under it. A rolled groove is formed instead of a scratch, and this not only responds to every change of hardness, but enables the absolute value of hardness on the Brinell scale to be calculated for every hour or minute during the ageing period. In a recent development the specimen and grooving tool are immersed in a bath of hot oil, so that changes occurring during what is known as "artificial ageing" can be recorded.

Discussion.

Dr. E. Giffen said a point he had had specially in mind in listening to the paper was a comparison between the sort of groove one got with a continuous test and the depression obtained with the Brinell test. With the latter the metal was squeezed out in all directions, whereas with the continuous test it was pressed out on two sides. That explained why the groove was wider with the author's test than with the Brinell test. At the same time, was there any difference in the amount of metal squeezed out? Again, did the ball which made the impression roll truly in its setting or did it act partially like an indenter tool? Did the frictional forces in the seating prevent the ball from rolling?

Professor H. W. Swift wondered whether this particular tool would not only provide food for thought, but food for worry. The main question was whether the test, as it stood at present, was of a quantitative or a qualitative character. There were one or two points which seemed to throw a certain amount of doubt on its claims as a quantitative instrument at the present time. At the same time, there were one or two points which no doubt the author could clear up. The first was the effect of the mound. He gathered that the shape of the mound on either side of the impression made by an ordinary impression tool differed according to the type of material, and he was wondering whether that tendency for the mound to form would not alter the factor for multiplying the width of a circular hole to get the groove.

Another question was the speed at which the rolling ball was passed over the material. In the case of an ordinary hardness test the depth and sectional area of the impression were both dependent upon the time during which the impression was made, and he inquired whether in the case of the rolled impression the width of the groove might not be dependent on the speed at which the rolling took place. Speaking with regard to the relative advantages of scratch measuring and rolled impression, he said that in the case of an ordinary static hardness test there was a difference owing to a certain amount of elastic recovery in the material. Were there any signs of that in this particular method, and, if so, which of the two methods had been found to be the more satisfactory? Finally, Professor Swift said he was not very impressed with the reasons for etching the ball, because it appeared to him that if this increased the friction on the specimen it would also increase the friction in the socket.

The Author, in reply, said that the effect of ridging did vary with certain materials, and for that reason the conversion factor also varied, but it took the difference into account. The Brinell test gave different

effects with different metals—sometimes there was a raised ring round the ball and sometimes there was a depressed impression—and the groove varied in a somewhat similar manner. If one was content with the Brinell hardness, one should be content with the groove made in the same metal and converted into Brinell hardness by a conversion factor. That seemed to him to be getting very near to an absolute measure of hardness. The speed at which the groove was rolled was not a matter of particular importance, since the rolling was extremely slow—much slower than in making a Brinell test. It was quite likely, of course, that a quickly rolled groove would exhibit different characteristics from one which was rolled slowly, but that did not seem to occur. He believed the time was a constant rate in all the experiments he had made and so slow that the effect of speed as a disturbing factor could be ruled out.

Continuing, Mr. Herbert said that all sorts of elastic recoveries were experienced which made the final shape of the groove after the load had been removed different from that when the load was on, and a good deal of investigation had been done in that connection. He had gone into that matter very closely and felt that as the recovery impression of the Brinell test was so constantly adopted, if he compared the Brinell impression with the recovered impression, that would be the nearest he could expect to get to a practical evaluation of the hardness. The ball was, of course, resting upon a relatively soft material in which the various projections and roughnesses were impressed, but it was revolving in a highly polished, hard steel socket which was quite impervious to any roughness and the rotation in the socket was not impeded by the roughness of the ball. As a matter of fact, it was very plainly seen by examining the groove itself that the ball did revolve. The etching was only used on a relatively soft material and it had the effect of producing a matt surface. At the same time, etching did not seem essential, as the ball would go round on most metals without being etched.

Permeability Testing.

On Wednesday, September 8th, Dr. L. G. A. Sims, of the British Standards Institution, read a paper on "The A.C. Method in Permeability Testing." He said that at the 1936 meeting of the British Association the Committee of Section G (Engineering) gave careful consideration to a report submitted by himself upon the case for a British Standard Specification relating to the incremental magnetisation of sheet steels. The British Standards Institution was officially represented at the reading of the paper and, in accordance with ensuing recommendations, a meeting of the B.S.I. Technical Committee on Transformer Steels was held in London on February 4th, 1937, when it was formally resolved that a case had been made out for the standardisation of a method of test for incremental magnetisation. A drafting sub-committee was accordingly formed and it was very gratifying indeed to record that leading authorities concerned with both the manufacture and the use of magnetic sheet steels, as well as with magnetic research and measurement, were now actively collaborating. The sub-committee's work to date had been based upon a questionnaire circulated in 1935–36 throughout this country, Europe, and America. In reviewing progress it was of interest to record a decision that measurements of incremental permeability should, if possible, be made by an alternating current method rather than by the ballistic method which had in the past been specified for the less complex "non-incremental" measurement. Thanks to a variety of experimental work now in hand and to the pooling of experience which the formation of the B.S.I. Committee had made possible, authoritative recommendations upon testing methods could be considered as certain, but any more detailed statement would be premature.

In conclusion, after the discussion of several points, the author said that the existing British Standard Specification for "non-incremental" magnetic testing (B.S.S. 601) contains certain clauses which are directly applicable to material intended for incremental working and others which permit of straightforward modification. These clauses, in modified form, constitute the framework in which it is hoped to construct the new specification.

Discussion.

Professor W. Cramp (Chairman), said that Dr. Sims' paper provided an opportunity of seeing that a determined attempt was being made to carry out work of this character not only by means of joint work in the two Universities, but also on an international basis. When a new thing like this cropped up it ought, as far as possible, to be made world-wide. In view of the fact that this should really come within the purview of the Committee known as the Committee of Terms and Units, it was very desirable that that Committee should take it into consideration and that Section G should ask Dr. Sims and his associates in London, as well as those who were doing the work in Birmingham, to carry on with the work and report upon it again next year at Cambridge.

The meeting signified its approval.

Flux Distortion.

The final paper in Section G (Engineering) was on "Flux Distortion in Iron Testing," by Mr. J. Greig and Mr. J. E. Parton, which was related to the previous paper by Dr. Sims on "The A.C. Method in Permeability Testing." The authors conclude by saying that although distortion factor appears to be intrinsically a satisfactory measure of flux distortion, sufficient data have not yet been accumulated or analysed for any very useful conclusions to be formed as to its possible utility as a general criterion by which the overall accuracy of permeability and loss measurements can be gauged.

Section A: X-rays in Industry.

On Thursday, September 2nd, the whole of the morning in Section A (Mathematical and Physical Sciences) was devoted to a symposium on "X-ray Methods and Industry." The chair was taken by the President of the Section, Dr. G. W. C. Kaye, who opened the meeting by saying that the feeling had been gathering strength during the past few years that the primary concern of the British Association was to bring home to the community how much its interests and welfare were bound up—and this would be the more so in the future—with science and its development. Having that in mind, the Committee of Section A this year had decided to devote the greater part of its proceedings to emphasising the beneficent influence of applied science on the national life in every aspect. In these disturbed days, science should have a message of goodwill to the world, and he felt that such a message was to be found in the subject of the discussion that morning.

Sir William Bragg, F.R.S., in opening the symposium, and speaking generally on the application of X-ray methods to industry, recalled that it was forty years ago that Röntgen discovered the rays which often, and most appropriately, bear his name, though the shorter title "X-rays," had become the more usual. After a brief reference to the value of X-rays in surgical and medical diagnosis, Sir William said that twenty-five years ago von Laue showed that X-rays were a form of light of exceedingly short wavelength, and opened up new fields of inquiry and usefulness, even more extensive than those of the original discovery. The shortness of the waves of X-rays, being of the order of one hundredth millionth of a centimetre, gave them a fineness which made it possible to examine the minute details of the atomic structure of solid bodies. Since the properties of every solid body depended on the structural arrangement of the atoms of which it was composed, the new knowledge had a bearing on the use of solid bodies, whether in the processes of Nature or in the activities of man. It had already had something to say, and in the future would have more and more to say, on every branch of science and every application of science to industry. It did not follow that when the structure of a solid body was known, all its properties were at once explained, but the determination of the structure was a necessary step to fuller knowledge, and even that first step led to important results.

Leaving the various applications of the new knowledge to industry to subsequent speakers, Sir William said the dimensional details of "structure" were extremely small in comparison with the visible dimensions of industrial objects, every one of which contained myriads of atoms and possibly a great diversity of arrangements. It was a long way from the one set of dimensions to the other, and it would take a long time to explore the country in between. Consequently, the accounts to be given of the application of X-ray methods to industry tended to fall into two distinct categories.

In the first place, there were many cases in which X-rays were employed because they gave, as nothing else could, a measure of the presence of some crystalline constituent or some degree of crystallinity without any disturbance of or effect upon the body to be examined. Moreover, the quantity required for the examination might be very small, of the order of a milligramme or even far less.

In the second place, there were those researches which looked for more fundamental knowledge, and tried to discover the laws which related structure to properties. The full consequences of those researches would be realised as time went on, and would far exceed those of the more empirical applications. They were, at the moment, more indirect than direct, throwing light on the basic science of industrial materials rather than on their handling in the workshop.

X-ray methods had already been widely applied to the study of metallic structures, and in the course of those determinations light had been thrown on various mysterious phenomena, such as hardening, annealing, slip, and the continuous creep which had become so important in engineering. Gough's work, for example, went far to give a true description of fatigue. The remarkable law of Hume-Rothery, illustrated by the researches of Bradley and others at Manchester, showed that the properties of certain alloys depended on the geometrical arrangement of the sites occupied by the atoms in the structure rather than on the nature of the atoms themselves. The number of possible alloys was enormous, and it was almost certain that many useful examples remained to be discovered.

Very interesting applications of X-ray methods had been made in the study of organic materials, whether lifeless, such as cotton, wool, and silk, or those closely connected with the living animal, such as muscle, nerve, vitamin, and so forth. The structures of general organic chemistry presented a wide range of interesting problems, as, for example, fats, paraffins, sugars, dyes, and carcinogenic substances. The silicates and clays comprising the greater part of the earth materials had been found to be built according to definite rules, a knowledge of which explained much of their behaviour. In that connection, the work bore on ceramics, refractories, and glasses, and on the problems of geology and of the agricultural properties of soils.

Most of the aspects which Sir William Bragg had mentioned in his opening remarks were dealt with by the later speakers in the discussion.

Dr. G. Shearer referred to the application of X-ray methods of investigation in the metal industry, and illustrated how these could provide a variety of information, much of which could not readily be obtained by other methods. Such studies, he said, gave directly the arrangement of the atoms in the metal, and showed how that arrangement altered, when, for example, other constituents were added to a pure metal to form an alloy. He instanced the addition of tellurium to lead and the manner in which by means of X-ray examination it had been ascertained how that addition assisted lead water pipes to resist the action of frost. Less fundamental in nature, but at times of more immediate application to industrial purposes was the further information which such examinations yielded. By means of X-rays it was possible to trace the effects on the structure of such processes as heat treatment, cold working, hardening, and the like. The size, the state of perfection and distribution in direction of its crystallites, all had an important bearing on the properties of a metal, and by giving information on those aspects X-rays extended the knowledge derived from studies with the microscope and helped towards a clearer understanding of the magnetic, electrical, and tensile properties of the metal. He showed how X-ray examination provided a great deal of information with regard to the size of crystals at the region where the microscope ceased to be effective, and referred to an instance in which X-ray methods had proved bad annealing to be the cause of trouble.

Messrs. J. T. Randall and H. P. Rooksby, of the General Electric Company's research laboratories, Wembley, referred to three recent investigations of the application of X-ray crystallography. Commenting on the industrial importance of fluorescent materials, and their extensive use for the colour modification and improvement of luminous efficiency in discharge lamps, the new interest given to these cathode ray tubes using fluorescent materials by the advent of television receiving sets was emphasised. The fluorescent substances employed in all such applications depended for their effects on the particular substance chosen, and on the particular impurities incorporated in them. Examples of those materials were shown, and it was pointed out that a knowledge of the crystal structure was of great importance, ensuring correct methods of preparation. It was shown how the colour of fluorescence could be varied by changes in the crystal structure, as well as by changes in the activating impurity. Although the existence of a green fluorescent zinc silicate—willemite—containing two molecules of zinc oxide and one of silica was known long before more recent interest in fluorescence developed, it had been found possible by altering the ratio of zinc oxide and silica, to prepare a second zinc silicate which, with suitable excitation, gave a yellow fluorescence. The crystal structure of that silicate, as would be expected, was entirely different from that of willemite.

X-ray crystallographic examination of a series of sulphide powders containing zinc and cadmium in various proportions, each powder being chiefly activated by copper, had also shown that the colour of fluorescence moved from green to deep orange red as the amount of cadmium sulphide increased and according to the lattice constant.

Another application dealt with a metallurgical problem, viz., the effect of cross-rolling molybdenum sheet. Such sheets, 0·1 mm. thick, produced by rolling from sintered bars of the metal, are used as blanks for the anodes of wireless receiving valves. Certain of these sheets, which had to be subjected to a forming and sand-blasting process, exhibited, it was said, a characteristic weakness as regarded resistance to bend in directions at 45 deg. to the direction of rolling. It was found that the fractures, which developed as a result of that weakness, only appeared in sheets produced by cross-rolling, *i.e.*, successive rolling in two directions at right angles. It was felt that if information could be obtained with regard to the orientation of the crystals in the molybdenum sheet, both for cross-rolled and for straight-rolled material, the cause of the 45 deg. fractures could be established. Comparison was therefore made by means of the X-ray method between cross-rolled and straight-rolled samples of sheet in the following way: —Two specimens were cut from each sheet, and set up so that the direction of the X-ray beam was respectively perpendicular and parallel to the direction of rolling. That gave orientation patterns for two directions at right angles. The X-ray patterns revealed that in the case of straight-rolled material the crystals became orientated so that a set of (110) planes was approximately perpendicular to the direc-

tion of rolling. That orientation still allowed of a rotation of the conjugate set of (110) planes around the rolling direction. If the material was rolled subsequently in a direction at right angles to the first, the second set of (110) planes assumed an orientation with respect to the new direction of rolling similar to that of the first with respect to the original rolling direction. That meant that a (100) face of the lattice cube was brought into the plane of the sheet. There would then be (100) planes perpendicular to the surface of the sheet and at 45 deg. to the directions of rolling. Those were cleavage planes, and so the orientation developed by cross-rolling resulted in a minimum strength in the 45 deg. direction.

A third application of the X-ray method mentioned dealt with the structure of graphite, and the authors drew attention to, rather than attempting to explain, one or two features having some connection with the recent work of Finch on that material. For many years physicists have been interested in the obvious similarities between the X-ray patterns of amorphous carbon, such as lamp black, and graphite, and it was in the course of work of this nature that the following points of interest came up. In comparing the patterns of amorphous carbons with various artificial graphites, it was thought advisable to include one of natural graphite. A specimen of a graphite powder of Bavarian origin was purified to remove silica, iron, &c. The X-ray pattern showed in addition to the usual lines, two new ones which should not have appeared if the structure at present assigned to graphite was entirely correct. Those lines had not previously been recorded by other X-ray workers on graphite, but it was noticed that the "extra" lines, together with a number of other extra ones, were obtained by Finch in the course of his electron-diffraction investigations. The X-ray patterns taken indicated clearly that the appearance of the "extra" lines was associated with the presence of larger crystals than occur in any of the artificial materials examined. Even so, natural graphite crystals were apparently too thin in certain directions for the whole set of "extra" lines observed by Finch to appear when X-ray technique alone was employed. The authors suggested that the new X-ray data, together with those of the electron-diffraction photographs, were sufficiently interesting to justify a new consideration of the details of the graphite structure.

Messrs. R. W. Powell and W. A. Wood, in a note on recent thermal and X-ray work on mica, gave a description of an adaptation of the divided bar method for determinations of thermal conductivities of insulating materials at elevated temperatures and of its application to the effect of temperatures up to 600 deg. Cent. on the thermal conductivity of mica normal to the cleavage plane. Certain micas of the phlogopite type were found to show a sudden decrease in thermal conductivity at about 200 deg. Cent., with a partial recovery only on cooling, but other specimens were found to be free from that anomaly. An X ray examination has been made of the variations exhibited by the structure of the same specimens during a temperature cycle of 16 deg. to 400 deg. Cent. It was found that the heat treatment might bring about a very marked mosaic formation without apparent change in external appearance. It was also found that such a structure is not final, but may revert partially to the original state on cooling, and also that a close parallelism existed between this effect and the abnormal fall in thermal conductivity.

The authors suggested that the combination of thermal and X-ray work in that case provided a specific illustration of a fruitful application of X-rays to the study of a material of industrial importance.

Dr. A. J. Bradley (Royal Society Warren Research Fellow), speaking on X-rays and the permanent magnet industry, said that powerful permanent magnets were made of alloys with a composition near to that of Fe_2NiAl, and their properties could be explained by X-rays. Powder photographs of slowly cooled Fe-Ni-Al alloys had given an entirely new phase diagram with many surprising features. The main single-phase areas were face-centred cubic (α) and body-centred cubic (β). It was formerly thought that the intermediate area was simply an ($\alpha+\beta$) region, but that was only correct at high temperatures. On cooling the alloy, the receding boundary left a new two-phase area consisting entirely of body-centred crystals with different compositions. That was possible because the β boundary on the nickel-rich side was curved like a bow. The two-phase ($\beta+\beta_2$) area, between the bow and the bow-string, included the composition Fe_2NiAl. On slow cooling that alloy split up into β and β_2, with lattice dimensions differing by 0·3 per cent. To develop maximum coercivity, the alloy was cooled at such a rate that there was not time to form two distinct types of crystal, but there was a continuous variation of composition.

It was agreed at the conclusion of the discussion that the Council of the Association should be asked to find some form of common platform whereby industry may be kept more closely in touch with developments in X-ray technique. A Joint Committee should be formed of all those sections of the Association whose interests brought them into touch with X-ray work.

The Iron and Steel Institute at Middlesbrough.

VISITS AND EXCURSIONS.

THE Autumn Meeting of the Iron and Steel Institute was this year held at Middlesbrough on Tees-side, in the midst of an area particularly noted for the production of iron and steel. In fact, Middlesbrough owes almost its whole importance to iron and steel. To-day it is a town with a population of over 140,000, lying in the midst of a closely populated district. But maps only one hundred years old show the place in very small type indeed, and it is on record that in 1821 it had only forty inhabitants. Its growth dates from the completion of the Stockton and Darlington Railway, which began to raise the status of the mouth of the Tees as a port, and was further accelerated by the discovery of iron ore in the neighbourhood. To-day Middlesbrough is a port from which iron and steel products are sent to all parts of the world. Architecturally, it is uninteresting, perhaps even ugly, and, in fact, many people paying a first visit to it may wish that it might disappear with a celerity at least as great as that with which it has grown. But industrially it is of great interest, and even the casual visitor passing through by train cannot fail to be impressed by the obvious activity of its steel and engineering works and of its docks. High above the river hangs the great transporter bridge, while further upstream the visitor finds, and cannot but be impressed by, the new vertical lift bridge.

This article is not concerned with the papers and reports presented on the mornings of September 15th and 16th, but with the visits paid by members to the many firms and works in the district. So many works visits were, however, included in the programme that it has proved impracticable for us to mention all, and we intend therefore to confine ourselves principally only to those works which we ourselves were able to see, mentioning others only on account of some point of special interest.

COCHRANES.

On Wednesday, September 15th, we chose to go to the Ormesby Works of Cochranes (Middlesbrough) Foundry, Ltd. These works are mainly concerned in the production of cast iron pipes, which are made by a centrifugal process. The production of cast pipes at Ormesby dates back as far as 1854, but until a few years ago they were all produced by the ordinary sand cast method, which, in fact, is still used to-day for the making of tees, bends, and other "specials." About fifteen years ago, however, the Stanton Ironworks Company, Ltd., started the production of pipes by the Delavaud centrifugal process, in which the pipe is cast in a rotating steel mould. Although this process had the disadvantage that the metal was chilled and that therefore it was necessary to anneal all the pipes produced, it soon established itself as a very economical method of manufacturing high quality pipes. Meanwhile another centrifugal process had been developed in Belgium, with the object of avoiding the expense of installing the annealing furnace. This, the Mairy process, was further developed by Cochranes. It consisted in essentials of dusting the spinning mould with a ferro-silicon compound before the metal reached it, and prevented the metal being chilled, thus rendering annealing unnecessary. By this means a pipe was produced with properties

FIG. 5—OPEN HEARTH PLANT—SKINNINGROVE

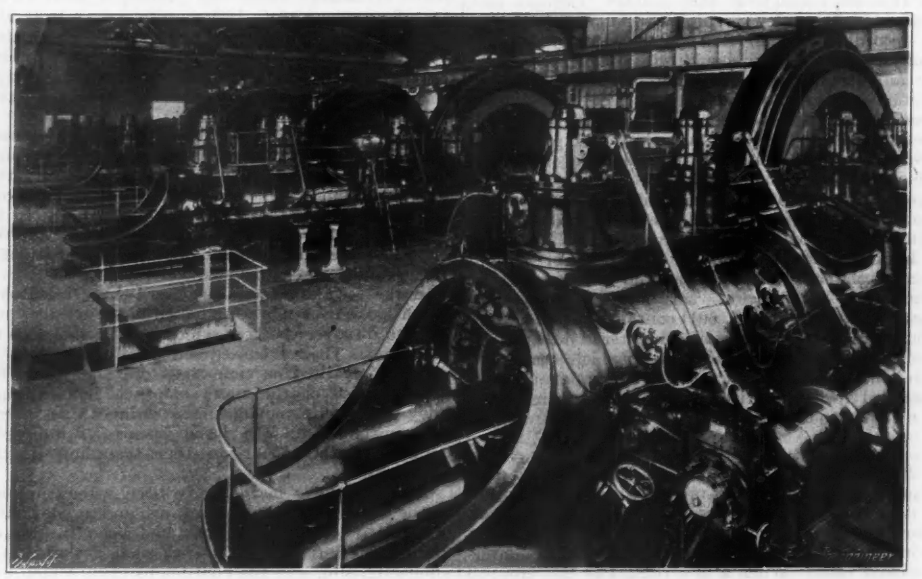


FIG. 6—POWER HOUSE—SKINNINGROVE

very similar to the Delavaud pipe. After a period of mutual competition, the two firms, Cochranes and Stanton, entered into an agreement, whereby the patents were exchanged, and the two processes were combined into one. Under the present system employed by both firms, the pipes are cast according to the Mairy principles, and are subsequently subjected to a normalising process in a furnace. By this means, so we were informed at the time of our visit, the strength of the metal of the pipes is raised as much as four times in comparison with the previous product without sacrificing ductility or workability.

The present pipe-producing plant at Ormesby was opened in June last year, and is suitable for the production of pipes from 3in. to 24in. diameter in lengths of 12ft., 18ft., and 21ft. There are six spinning machines arranged alongside one another, and so placed as to be conveniently supplied by crane with hot metal from the melting plant. The machines each consist of an outer cast ribbed casing in which the accurately machined steel mould is supported on friction rollers and bearings. An electric motor is mounted at one end of the casing, and rotates the mould through suitable gearing. Water at a constant predetermined temperature is circulated between the mould and the casing. The whole mould assembly is carried on rails along which it can be moved axially by hydraulic mechanism. It is also slightly tilted, the motor being mounted at the lower end. Beyond the upper end there is a gallery upon which are mounted on trunnions the tilting casting ladles for the six machines. Each ladle feeds into a cantilever trough which projects downwards into the interior of the mould sufficiently far to feed the furthermost point when the mould is drawn as far up as possible. In action the tilting ladle is first filled with the molten metal, as shown in an engraving on page 338. The mould is then set spinning and the metal running down the trough feeds its further end. With the mould still spinning the mould assembly is slowly pushed back by the hydraulic mechanism, so that metal is progressively fed along the length of the mould until when the upper end is reached the tilting ladle is empty. The cantilever arm is bored throughout and ferro-silicon powder is forced down the bore to drop into the mould just before the metal reaches it. It will be observed that if this method of casting is to produce a pipe of even thickness the flow of molten metal along the trough must be regular. This regularity is obtained by linking the tilting ladle to the hydraulic mechanism so that the tilt of the ladle is controlled by the travel of the mould. The further requirement—that the metal should be at a suitable temperature—is controlled at the melting plant.

Most, if not all, of the pipes cast are shaped at one end to form a joint with the other end of a similar pipe. The formation of the end usually requires that there should be a core. These cores, which are made of oil sand, are mounted on circular steel plates adapted to be rapidly engaged with the lower end of the steel mould by means of a system of wedges. At the conclusion of pouring the moulding box is at the lower end of its "stroke." The wedges are knocked out and the core withdrawn. Next, a man stationed at this point for the purpose inserts a special pair of tongs over a fixture into the end of the pipe. The moulding box being now caused to travel up the incline, the casting is held and left standing alone in the lower position. It is rolled aside on to a truck which conveys it to rails along which it is man-handled to the entrance of the normalising furnace.

At this stage it is interesting to note that, contrary to expectation, the pipes are not all entirely straight. The normalising furnace is depended upon to put the matter right. This furnace is of the continuous variety and takes pipes of all sizes produced. It is fired by clean producer gas and has as its chief objects the relieving of any initial strains and the conversion of the structure of the iron to a tough condition. The pipes are rolled through the furnace at a predetermined speed, which is regulated by means of a chain conveyor fitted with heat-resisting steel fingers which keep the pipes correctly spaced.

On emerging from the furnace the pipes are transferred to gantries serving the testing machines. On their way to these machines the bores of all pipes are smoothed by portable grinding machines, while one section of the gantry is arranged as a weighbridge. Testing of the pipes hydraulically follows, and they are then passed into a reheating furnace heated by waste gases from the normalising furnace. Here they are raised to the temperature suitable for the dipping which follows. Beyond the dipping tank the pipes are either loaded up for despatch or passed into stock.

FIG. 7—LIGHT TROUGHING PRESS—CLEVELAND

Although a works of this kind does not lend itself well to mechanisation and although the pipes are man-handled on the gantries from place to place, the whole plant impressed the visitors greatly as an example of very careful planning and control. Before leaving, the party was able to witness a test on a pipe chosen at random from stock.

Other parties on this day visited various works of Dorman Long and Co., Ltd. In the evening there was a party at Mount Grace Priory, by invitation of Sir Maurice Bell. This priory was founded by the Carthusians, and the walls of the cloisters and much of the church still remain standing. The Carthusian order was very severe, requiring that the monks should live in almost solitary seclusion. Each monk lived in a large cell the door of which opened off the cloisters, and had also a garden to himself overlooked by no one else, and reached only from his cell. He emerged only to attend service in the church. Except on Sundays and other special days, when the monks had their meals together, food was served to him by a lay-brother through a special right-angled serving hatch so arranged that neither could see the other. Many of these hatches still exist. After dinner the ruins were floodlit.

SKINNINGROVE.

The works of the Skinningrove Iron Company, Ltd., which we visited on the Thursday, September 17th, are situated on the coast a few miles south of Saltburn. This site was originally chosen by the Loftus Iron Company about 1875 on account of the Loftus mines close by from which the necessary ironstone is obtained. The configuration of the land in this part of Yorkshire consists of high rolling country into which penetrate unexpectedly deep valleys. One of these valleys runs down to the sea at the site and within its protection a village has grown up. High above this village where the sides of the valley flatten out at the level of the surrounding country, the works are situated.

Ore is brought to the works on an aerial ropeway, and pig iron, rolled sections, and other products are sent by rail and by sea to their markets. There are five blast-furnaces, four of which are at present in operation. One furnace was rebuilt last year after producing 1,300,000 tons of pig iron on a single lining. The furnace not at present in operation is dismantled and is to be replaced by a new furnace. Eleven Cowper stoves serve the furnaces, which are supplied with air by a combined gas, electric, and steam-driven plant with a capacity of 110,000 cubic feet per minute delivered at 10 lb. to 12 lb. per square inch pressure. Full use of all the blast-furnace gas produced is made, and the further power needs of the works are supplied from the mains of the North-Eastern Electric Supply Company, Ltd. The gas is first passed through towers where it is brought into contact with water sprays, and thence it passes into a series of Theisen disintegrators. The cleaned gas is not only used for heating the Cowper stoves, but also in the mixer in the melting shop, in the soaking pits, in the wash heating furnace for the roughing and finishing mills, and as fuel for eight gas engines driving generators—Fig. 6—five of which generate at 2750 volts and two at 440 volts, and one blowing engine.

The melting shop, Fig. 5, contains three open-hearth furnaces of the Talbot tilting type, one of which is designed to give an output of 2000 tons per week, and the other for an output of 1500 tons per week. There is also a 400-ton mixer fired with blast-furnace gas. This shop is served by two mechanical chargers. The furnaces are tapped into 60-ton ladles, which are travelled by the casting crane over ingot moulds placed on casting bogies. An hydraulic stripper is placed immediately outside the melting shop, and the stripped ingots are conveyed directly to the four soaking pits. Thence the ingots are conveyed by chariot direct to the mills. They are first passed through an electrically driven 42in. cogging mill operated by a 14,000 H.P. motor. From the cogging mill blooms are passed through 36in. roughing and finishing stands driven by a 18,500 H.P. motor. At one time all the sections supplied where rolled in this mill, but some eighteen months ago it was decided to install an 18in. mill to cope with an increasing demand for lighter sections, thus relieving the larger mill of these duties. The new mill—Fig. 3, p. 338—consists of three stands of three-high rolls, fitted with rising tables on the outgoing side, and is driven by a 1200 H.P. motor through a reduction gear with two fly-wheels mounted on the motor shaft. The mill is fed with 6in. blooms, which are cogged down in the cogging mill, the arrangements being such that the hot blooms may be charged direct into the reheating furnace or cold blooms rolled from stock held in the storage bay of the mill. The reheating furnace is of the continuous type, and is fired with pulverised fuel.

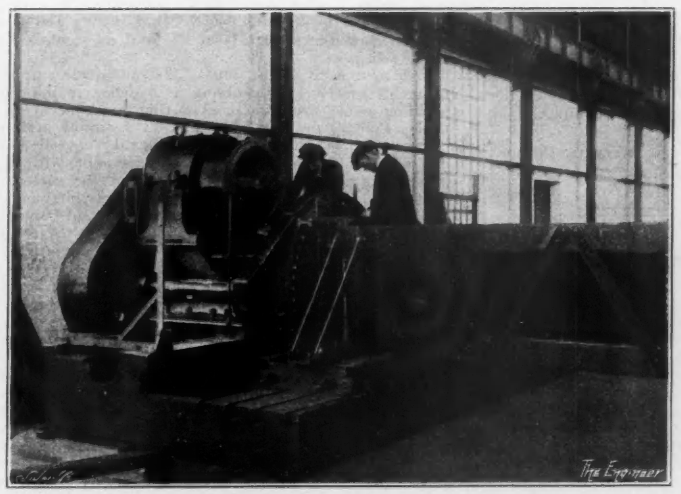


FIG. 8—FACING ENDS OF BRIDGE MEMBERS—CLEVELAND

FIG. 9—VERTICAL ELECTRIC FURNACE—DARLINGTON FORGE

Works of Dorman, Long and Co., Ltd., were again visited by other parties, and another party went to the Cargo Fleet Works, of the Cargo Fleet Iron Company, Ltd. In the evening there was a ball and supper at the Town Hall, Middlesbrough, by invitation of the Reception Committee.

CLEVELAND BRIDGE.

On the following day we visited the Cleveland Bridge and Engineering Company, Ltd., and the Whessoe Foundry and Engineering Company, Ltd. The first-named firm is engaged on constructional

work, and has supplied the steelwork for many well-known bridges. In addition, it undertakes the manufacture of steelwork for such things as workshops, power stations, floating landing stages, pipe lines, dock gates, and observatories. The firm, as is well known, also contracts for the founding and erection of large structures of all kinds. The works cover an area of about 30 acres, and are divided into several departments. Materials are first received in a large materials yard, where they are checked for size, flattened and straightened. Bars and sections are cropped and sawn to lengths. Before undertaking much manufacture on any large structure, wood templates are made in a template shop, in which the structure concerned is drawn out on the floor at full size. The various members are then cut and formed in accordance with the templates. Plates are cut to size in a large guillotine shearing machine, and long flanges and webs are planed on the edges. The firm has adopted the practice of only drilling sufficient holes in plates and bars at first to allow them to be tacked together, and the other holes are drilled through all component parts at one operation. This practice not only ensures that the bolt or rivet will be a perfect fit, but also results in a saving of time. There are more than seventy radial arm drilling machines in the various shops, some of which are to be seen in Fig. 2. The main assembling shop is 800ft. long, with a span of 90ft., and is served by three 30-ton cranes.

All bridges and large structures are temporarily erected in a large erection yard with four bays from 500ft. to 900ft. long, each served by an overhead Goliath crane. Before dismantling, all the members are marked with distinguishing letters. After dismantling, the steelwork is thoroughly cleaned and painted, and the painted markings are not only repainted on, but also repeated by metal stamps in case the paint mark becomes obliterated. In going through the yard we noticed under erection a large domed observatory building, being supplied to the order of Sir Howard Grubb Parsons and Co. The firm makes use in some departments of oxy-coal gas for cutting plates. The gas is taken directly from the gas company's mains and the process has the advantage that a narrower cut can be made of about $\frac{1}{16}$in., and that the cut surface is smoother. The flame does not appear to harm the nature of the metal. The engraving, Fig. 7, shows the process of pressing light troughing, as carried out in the works.

Whessoe Foundry.

The Whessoe Foundry and Engineering Company, Ltd., is also concerned mainly with structural work, but specialises particularly in the production of oil storage tanks, of which examples have been made up to 140ft. in diameter. The history of the firm goes back as far as 1790, when William Kitching started a foundry in the centre of Darlington, which was moved some ten or twenty years later to the present site. William Kitching, it may be mentioned, built some of the earliest locomotives, the "No. 25" on the Darlington Station being one of his products.

The main shops now existing were built in 1927–29. There are three principal bays, 370ft. long and 48ft., 61ft., and 61ft. wide respectively. They are so laid out that incoming material is received at the south end and finished plates, sections, &c., are delivered at the north end to the erection yard. The erection yard has been built to be specially suitable for the erection of tanks. It is circular, 240ft. in diameter, and formed on concrete. A circular railway track encircles it, and by the use of locomotive cranes and two Morris mobile cranes, the work of erection can be expeditiously carried out. After erection and dismantling, plates are taken to the pickling shop. The system of phosphoric acid pickling is a recent development of the firm. The work is carried out in a shop, 300ft. long by 48ft. span, and the pickled steel, which we observed, was completely free of scale, is painted immediately after leaving the pickling bath. The plant deals with some 500 tons of steel each week.

Darlington Forge.

Another party paid a visit to the works of the Darlington Forge, Ltd. This firm, which was founded some ninety years ago, manufactures ships' structural castings and forgings, and high-pressure boiler drums, and forgings and steel castings for general engineering. Owing to the prolonged slump in shipping it was necessary in 1932 to close down the works. Fortunately, however, the English Steel Corporation, Ltd., realising that a revival of trade could not be long delayed decided to take over the works with the intention of reopening them as soon as trading prospects justified this course. By 1936 the anticipated revival was well under way, and the works were reopened in January of that year. The works have been reconditioned and much new plant installed and this improvement is still being continued.

Two acid open-hearth furnaces, one of 60 tons and the other of 40 tons capacity, supply the steel used in the heavy foundry, the forge, and the hammer shops, and two 3-ton stock converters supply the light foundry. The forge has four presses from 1500 tons to 3000 tons capacity, capable of dealing with ingots up to 100 tons in weight, while the frame shop is equipped with a large gap hammer which is used chiefly for the assembly and welding up of large frames which have been forged in sections under a press. In the latter building there is a new 4-ton steam hammer and two air-regenerative producer gas-fired furnaces. In accordance with the rapid progress recently made in the application of scientific heat treatment to large steel forgings and castings, an entirely new heat treatment department has been built. There is a vertical electric furnace, Fig. 9, capable of dealing with forgings up to 30ft. long by 2ft. diameter installed below floor level in a water-tight caisson 17ft. 6in. diameter, a horizontal bogie electric furnace for forgings of the same length, and five producer gas-fired furnaces, three of which are single-ended air regenerative, 25ft. by 6ft., 40ft. by 8ft., and 24ft. by 16ft., respectively, and the others a single-ended non-regenerative, 65ft. long, and double-ended air regenerative, 45ft. long. There are vertical and rectangular oil dipping tanks and an oil-cooling plant. Gas is supplied by two 60 cwt. Morgan gas machines with mechanical coal-handling plant. It is satisfactory to learn that this works, which is also equipped with machine shops covering nearly 2½ acres, is now fully occupied and finds employment for over 1000 persons.

Head Wrightson.

Another firm of which some mention may be made and which was visited by a party of members on the Friday, is Head Wrightson and Co., Ltd., of Thornaby. This firm was founded nearly 100 years ago, and controls four works, the largest of which—The Teesdale Ironworks—was the one visited by the Iron and Steel Institute. The engineering works of the firm are largely devoted to the manufacture of specialised equipment for blast-furnace and general steel works plant, and also for the sheet and tin-plate industries.

The autumn meeting was concluded by a garden party held at Solberge Hall by invitation of Mr. Benjamin Talbot, a Past-President of the Institute and chairman of the reception committee. It was a matter of great regret to all the members that owing to ill-health he was unable to take any active part in the proceedings of the Institute on Tees-side, and it was an additional misfortune that the rain should choose to fall on the afternoon selected for the garden party.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

THE SALARY AND STATUS OF THE ENGINEER.

SIR,—As one who for many years has held the view that there should be more co-operative action by engineers, I should like to support the letter on this subject in your issue of September 10th. I would also say that some time ago I approached one of the major institutions on the subject, and was told that, if work of the character suggested by "Narwil" were undertaken, the income tax demand would be considerably increased. Possibly, however, there may be hope of action through the medium of the newly formed Public Relations Committee. I do not know what its constitution is nor anything about its terms of reference, but it seems to me that it might form a clearing house for matters common to all members of the engineering profession, and in that case it could surely consider the possibility of some effort on the lines suggested in my Presidential Address to Section G of the British Association last year.

WILLIAM CRAMP.

Birmingham, 15, September 16th.

Electrical Accidents in Mines.

THE report of H.M. Electrical Inspector of Mines, Mr. J. A. Bernard Horsley, for the year 1936 contains descriptions of all fatal accidents in collieries during that year, as well as selected non-fatal accidents and dangerous occurrences. As recorded in a Journal note appearing in our last issue, there were nine accidents in mines under the Coal Mines Act, 1911, involving the loss of twelve lives definitely attributable to the use of electricity, and one explosion of firedamp and coal dust where the balance of the evidence indicated that electricity was the probable cause. Six of these were instances of electric shock, with one person killed in each case, and in addition one person injured in one of them. There were three ignitions of firedamp in which six lives were lost and two persons were injured, and one—viz., that at the Wharncliffe Woodmore Colliery—in which fifty-eight lives were lost. The severity of the latter explosion was due to causes unconnected with electricity, and are dealt with in the Commissioner's report on the explosion. The origin of the disaster was attributed to open sparking at the commutator of a small D.C. loader motor in the gate road. The end cover had been taken off the motor, apparently for the purpose of routine examination, and the flexible cable was found plugged into the socket on the starting switch at one end and into the socket of the roadway switch at the other end. Following this explosion a circular was sent to all collieries to direct attention to the danger and illegality of the practice existing at some mines, in places that are worked with safety lamps of opening the enclosing case of electrical apparatus to make adjustments to or for the purpose of routine examination.

While operating a coal-cutting machine at the Preston Links Colliery, East Lothian, on December 21st, a machine man received a fatal shock. The trailing cable which had been trapped between the rope and the guide pulley, was sufficiently damaged to fuse and sever one live core, and the earthing conductor, and to leave another live conductor in contact with the pulley. The supply was three-phase, 500 volts, with the neutral insulated. Investigation failed to show whether the gate end circuit breaker had tripped automatically before the isolator was operated by hand. It had over current trips on each phase, and they were set to operate at 62·5 amperes in 20 sec. While the man was at the controls, his assistant who was watching the jib, heard a sound and on turning touched the machine and received a severe but transient shock. The assistant thereupon hurried to the switch at the main gate, about 30 yards away, put the isolator handle to the off position, and returned to the machine, where he attempted to revive the injured man. Artificial respiration was applied for an hour and a half without avail. While the accident was due to carelessness of the machine man, the consequences might have been different if the screened cable had been used with leakage protection, which implies earthing the neutral point.

Another coal-cutting machine accident is recorded at the Crofton Mill Pit, Northumberland on January 24th. While coiling the trailing cable of a coal-cutting machine into a kibble during flitting, the machine man received a shock through both hands and was killed. When the accident occurred the machine was being flitted under power, and the charge hand at once stopped it and tried by appropriate means to release the man, but was unable to do so. He therefore ran to the road switch some 20 yards away and switched off the current. Artificial respiration was ineffectual after one and a half hours. In this case the neutral was earthed and the three-phase pressure was 625 volts. The cable was of the plain four-core type, with a double hemp braid embedded in the outer tough rubber sheath. The place was wet and the cable covered with mud. Although inspection failed to reveal the fault, a subsequent high-voltage test brought to light a puncture where the cable had been repaired. After the accident screened cables were substituted for those previously in use and an improved routine was established for the examination and testing of trailing cables. Leakage protection was in use.

On December 5th, a coal-cutting machine man at the Woodend Colliery, Linlithgow, received a fatal electric shock from a machine which became alive in consequence of an insulation breakdown in the starting switch. Investigation showed that the earthing conductor in the trailing cable had become detached from its terminal in the flat bat at the machine. The supply was three phase at 550 volts, with the neutral earthed. Evidence that the earthing conductor was detached before the fault in the starting switch occurred was provided by the fact that the fuses in the gate end switch-box had not blown. It was found that the moulded micanite insulation covering the square bar carrying the finger contacts of the star-delta drum starter was burned through between two contact fingers. When the bat was opened it was seen that the earthing conductor had been drawn out of the clamp so as to be clear of the terminal and casing. Artificial respiration applied for 1½ hours again proved ineffective. Automatic earth continuity protection, coupled with leakage protection, the report states, offers good insurance against such accidents, but where these safeguards are not employed systematic and frequent inspection and testing by an electrician is specially important.

At the Ashington group of collieries in Northumberland, where there are some 56,000 yards of trailing cable in use, every cable is examined *in situ* daily by an electrician and insulation and conductivity tests are made at fortnightly intervals. Moreover, each cable is brought to the central repair shops for thorough overhaul once in three months as a matter of routine. Coupled with the use of screened cables and leakage protection these precautions have proved so effective that during the last nineteen years there have been no fatal accidents with trailing cables.

Three men were fatally burned in consequence of an ignition of gas caused by arcing at a defective joint in a trailing cable near the coal-cutting machine in the Brierley Colliery on December 2nd. The supply system is three phase at 550 volts, with the neutral point earthed. The trailing cable was a five-core pentagon cable with the five conductors of equal size. It was of the screened variety having a close copper rope screen of thirty-eight strands, each of 14/0·012 tinned copper wires laid between the inner and outer tough rubber sheathes. As seen immediately after the accident, the cable was drawn taut along the coal face and partly buried by cut coal and dirt between the gob side props and the conveyor frame. It passed over the top of the machine to the plug socket at the haulage end as the machine was then travelling away from the gate end near which the surplus length of cable was coiled. A small hole was seen in the cable sheath about 12in. short of the machine. There were five circuit breakers between the transformer for the district and the machine. Two having direct-acting leakage trips were tripped when the cable fault developed. When the defective joint in the trailing cable was dissected it was seen that there was a fused break in one of the power circuit conductors, and that the arcing which caused the explosion was not due to a short circuit, for the insulation of the other four conductors was undamaged. The trouble was simply due to the load current passing at the point of fracture. A hole had been burned by the arc through the insulation and the inner rubber sheath, and had reached the external atmosphere through an existing hole in the outer rubber sheath. The arc had fused three of the screen strands and the resulting current to earth had caused the leakage trips in two of the switches to operate and isolate the faulty circuit.

It was found that four of the five cores of the cable had been jointed with soldered ferrules, all the joints lying within a length of 6in. of cable. The rope strands of the screen had been jointed by twisting the ends together and four bands of copper wire, ¾in. wide and 1½in. apart, had been applied over the screen and soldered; but as these bands were not interconnected their purpose was not clear. The outer rubber sheath was very thin in places over the bands, and it appeared to have been split at the edge of one of the bands where the arc passed to the atmosphere. As repaired, the screen did not completely cover the cable coils, for there were spaces between some of the strands,

but similar spaces were observed in the unrepaired and adjacent parts of the short length of cable dissected. It was evident that while the repair had been made carefully there was a lack of knowledge on the part of the workman, especially with regard to the stiffness introduced at the joint that made it likely to break down. Where more than one conductor of such a cable has to be jointed it is essential that the joints should be widely spaced in order to avoid local rigidity.

A stonemason using a pneumatic pick on January 18th at the Rising Sun Colliery, Northumberland, to remove brickwork from outside the shaft wall to free the end of a steel girder during the construction of a new inset, pierced a high-voltage armoured cable on the other side of the wall and received such severe burns from the resulting arc that he died in hospital eight days afterwards. The electrical system was three-phase at 2750 volts with the neutral point earthed. The circuit was controlled by an oil-immersed circuit breaker with three relay-operated overload trips. This breaker cleared the fault, which also caused the main circuit breakers on the input and output sides of the three 20,000/2700-volt three-phase transformers with an aggregate rating of 3500 kVA to trip. The cable was three coil, with a section of 0·10 square inch, paper insulated, lead sheathed, and double wire armoured, with the usual outer covering. About 12in. of the cable conductors were fused away and the armouring was also fused on one side. Two inches of the pick point were also fused.

While at work at the Orgreave Colliery, Yorks, on June 27th, a painter climbed a steel trellis mast carrying high-voltage lines. Some of them were alive and he received a shock and severe burns and then fell 35ft. to the ground. The pressure of the three-phase system was 3300 volts with the neutral point earthed through a current limiting resistance. The 3300-volt conductors were 10ft. below the top of the mast, where the 11,000-volt conductors were attached. Arrangements had been made to shut down the 11,000-volt circuit to replace a broken insulator, and the opportunity was taken to carry out the painting work; but although the 11,000-volt circuit was isolated, the 3300-volt line was forgotten. It was fortunate that only one man was killed, for the foreman painter was climbing the same mast as the man who met his death, while another painter climbing another mast which also carried the live circuit had in fact passed above the 3300-volt conductors. The engineer had given instructions to the foreman painter the day before to arrange with the chief electrician to have the line made dead, and the chief electrician in turn told him to see the foreman electrician, but for some reason not explained the circuit was allowed to remain alive. The safety of workmen who have to work on transmission lines, the report states, can only be ensured when there is an established routine rigidly enforced and supervised. In this instance the safety of the painters can only be described as haphazard.

An assistant electrician at the Ferndale Colliery, Glamorgan, met with a fatal accident on March 19th. Having taken off the cable terminal box cover on the incoming side of a high-voltage switch in a haulage room, he touched one of the 3000-volt exposed terminals, and was electrocuted. The object of removing the cover was to ascertain the size of the cable conductors, for the switch was to be replaced. The circuit should have been isolated at the pit bottom switch room, some 100 yards outby, and the man ought to have been instructed to do this. Ten minutes elapsed before artificial respiration was begun, and after another ten minutes a doctor decided that further efforts were of no avail.

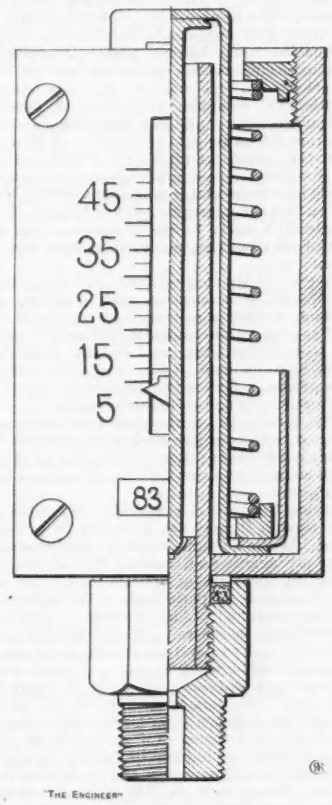
Other fatal accidents due to the ignition of fire-damp were at the Garlshore Colliery, Dumbarton, and at the Polmaise Mine, Stirling. In the former case a coal-cutting machine man and his son received severe burns when firedamp was ignited by the use of the control switch. Owing to the machine being very defective an opening was produced in the switch chamber, ignition occurred, and in consequence the boy was killed on the spot, and the father died a week afterwards in hospital. The other accident, which resulted in three men receiving burns and one losing his life in consequence of his burns, was due to the ignition of firedamp by arcing in the squirrel-cage rotor of a motor driving an auxiliary ventilating fan. When the motor was dismantled, it was found that the stator insulation was carbonised, and otherwise damaged. One of the rotor bars was broken at both ends, and was protruding at one end an inch beyond the short-circuiting end ring next to the fan. This projecting end was bent where it had been striking the stator end turns, and six other bars, irregularly spaced round the rotor, were also broken at one end. Sparking at the broken rotor bars was quite sufficient to account for the ignition of firedamp.

SIXTY YEARS AGO.

ON September 23rd, 1877, Urbain Jean Joseph Le Verrier died at Paris at the age of sixty-six. In our next succeeding issue, that of September 28th, we devoted over three columns to an account of his life and achievements. It is doubtful if many of our readers to-day could say offhand who Le Verrier was and what he did. Yet in our opening sentence we spoke of him as one who, more nearly than any other, might be styled the nearest to Newton of our times. He was not an engineer although after leaving the Ecole Polytechnique his first appointment was as engineer to the Royal Tobacco Monopoly. He was not a chemist although he published two early papers on the combination of phosphorus with hydrogen. If we must give him a label we may call him a mathematical astronomer. At the age of twenty-eight he presented to the Academy of Sciences two papers which forecast the nature of the work on which his subsequent fame was to rest—two papers on the limits of excentricity and inclination of planetary orbits. Later at the request of Arago, then in charge of the Paris Observatory, he re-examined the perturbations of the planet Mercury. His methods were so successful that he extended them to a similar study of Uranus. It had long been known that the perturbations in the movement of this planet could not be wholly accounted for by the influence on it of Jupiter and Saturn and it had been suggested that the residual discrepancies in its motion could only be explained by the existence of an undetected planet inside or outside the orbit of Uranus. In three papers presented to the Academy of Sciences between November, 1845, and August, 1846, Le Verrier developed this theme, giving, in the third, data concerning the mass, period and orbit of the unknown planet and forecasting where, on a particular date, it would be found in the heavens. On September 18th, 1846, he wrote to his friend Galle of Berlin asking him to direct his telescope to the point indicated by his calculations. On the very first attempt—on September 23rd—Galle found a strange star in the region specified by Le Verrier, a star of the eighth magnitude. The next night the stranger was observed to have changed its position. Its motion was found to agree exactly with that forecast by Le Verrier. . . . Thus was Neptune found. The romance of its discovery—one of the greatest, in its popular appeal, in the history of science—was heightened by a very human story. In July, 1841, a young Cambridge undergraduate, John Crouch Adams, made up his mind that as soon as he took his degree he would study the perturbations of Uranus. He graduated in 1843. In September, 1845, he communicated his results to Challis, the head of the observatory at Cambridge, and in November of the same year told Airy, the Astronomer-Royal, where the undetected planet was to be found. His forecast, it was afterwards found, was almost identical with that made by Le Verrier a year or so later. Airy, however, was not satisfied with it and Challis did not begin his search until August, 1846. Challis, proceeding leisurely, was hampered by the want of a good star map. He actually observed the new planet on August 4th, but failed to recognise it as a moving body. Adams' disappointment and Airy and Challis's chagrin when six or seven weeks later Galle's discovery was announced were severe. Some recompense to Adams came in 1848. When the Astronomical Society of London in that year awarded its gold medal to Le Verrier it also gave to Adams a similar one. . . . In 1930 the story was continued. Following the predictions of Lowell, based on a study of the perturbations of Neptune, a still more remote planet, Pluto, was discovered.

A New Hydraulic Pressure Gauge.

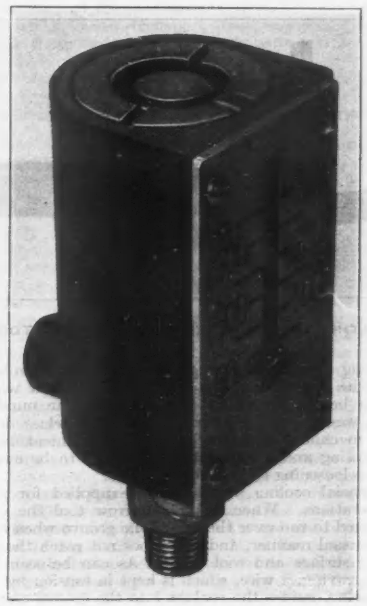
WE illustrate herewith a new type of pressure gauge for use on hydraulic machinery, which is now being made by A. Schrader's Son Division of Scovill Manufacturing Company, 829, Tyburn-road, Erdington, Birmingham. It is constructed on a similar principle to the firm's familiar type of tire pressure gauge. It is claimed that this type of gauge is better able to withstand the high and changing loads imposed by hydraulic machinery and can be made to give more positive readings than the conventional dial gauge. It is easy to read and its robust construction reduces the liability to accidental damage. At present the gauges are being made in seven sizes with ranges



PART-SECTION OF PRESSURE GAUGE

varying from 5 lb. to 50 lb. per square inch up to 1500 lb. to 5000 lb. per square inch.

The simplicity of the construction of this gauge makes possible a very fine degree of accuracy, both in manufacture and in pressure registration, whilst its few working parts can be made strong enough to withstand frequent overloading. As may be seen from our drawing, the mechanism of the gauge comprises a piston or plunger fitted to fine limits and free to move within a cylinder against a coil compression spring. The accuracy of the fit between the stainless steel piston and brass cylinder allows a minimum of oil seepage, but oil leakage past the piston is finally eliminated for all practical purposes by the addition to the bottom of the piston of a composition plunger cup, while a positive locking arrangement between the cylinder and the adaptor is provided to prevent those parts from becoming loose and turning in the housing under the influence of severe service conditions. The compression spring is supplied to the company by another firm specialising in such products, and it is pointed out that



HYDRAULIC PRESSURE GAUGE

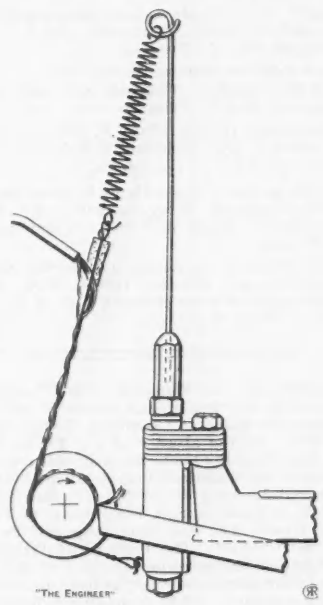
these springs do not have to withstand any more abuse than the exhaust valve spring of a modern high-speed internal combustion engine.

The indicating parts of the gauge are made sufficiently strong to eliminate the necessity of a protecting glass front. The face is made in aluminium alloy with a silver matt finish, which does not mark or soil readily. The design of the gauges is such that they may be fitted as replacements to dial gauges without alteration to the unions and couplings.

A New Lathe Toolholder.

ILLUSTRATED in the accompanying engravings is a new type of lathe toolholder, for which the agent in this country is F. H. Ockenfels, of Slough, Bucks. As can be seen from the illustrations, this toolholder, known as the "Universal" toolholder, differs from other types in that a pack of spring washers is employed to connect the shank and tool housing. It is claimed that the action of the old type "swan neck" tool is thereby obtained, and also that the spring pack acts as a safety device against overloading, allowing the tool to spring down instead of breaking.

The half-tone illustration shows the toolholder with a special parting tool. This tool is dovetailed so that it

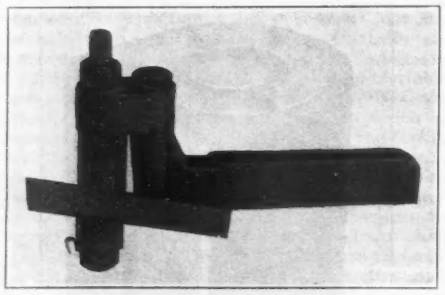


TOOL HOLDER AND COOLING ATTACHMENT

can be securely held by tightening the nut, visible at the bottom of the housing. In order to provide clearance the tool is tapered in thickness in the usual way, and it is also tapered in length, so that, by placing the wider end to the front it becomes impossible for the tool to slip backwards under heavy loads. It is stated that very thin tools, down to $\frac{1}{4}$in. in thickness, can be safely used for parting off operations, resulting in economy of production time and material. The protection afforded by the springs is tested for each holder by winding the tool up

to the flat of a 1¼in. hexagonal bar and then setting the lathe in motion. It is claimed that the tool springs down, leaving the point undamaged.

For sliding and facing work a dovetailed turning tool can be used in place of the parting tool. By unscrewing one nut the tool housing can be quickly removed and replaced by another, to adapt it for internal work, such



LATHE TOOL HOLDER AND PARTING TOOL

as boring and screw cutting. The toolholder can also be used with form tools, the usual chattering of which is said to be eliminated by the springs. The number of spring washers can be varied to suit the class of work being machined, and the jointed arrangement between the housing and shank enables the tool to be swivelled without loosening the tool-box.

A special cooling attachment is supplied for parting off operations. When using a narrow tool the coolant is inclined to run over the top of the groove when applied in the usual manner, and thus does not reach the actual cutting surface and tool point. As can be seen in the line engraving, a wire, which is kept in tension by means of a spring, guides the coolant into the groove and on to the tool point.

The toolholder is made in two sizes, the smaller holder using tools from $^{5}/_{64}$in. in width for parting off bars up to 1⅜in. diameter; the larger size can part off bars up to 3in diameter. These capacities are based on using the automatic cross-sliding motion; if the hand feed is used it is said that these sizes can be considerably increased.

BOOKS RECEIVED.

Railway Handbook, 1937–1938. London: *Railway Magazine*, 33, Tothill-street, S.W.1. Price 2s. 6d. net.

How to Estimate. Sixth edition. By J. T. Rea. London: B. T. Batsford, Ltd., 15, North Audley-street, W.1. Price 16s. net.

British Rainfall, 1936. London: His Majesty's Stationery Office, Adastral House, Kingsway, W.C.2., Price 15s. net.

The Advancement of Reinforced Concrete, 1932–1937. London: Reinforced Concrete Association, 91, Petty France, S.W.1.

Stainless Steels. By P. H. Miller. London: Oxford University Press, Amen House, Warwick-square, E.C.4. Price 3s. 6d. net.

The Magneto-theodolite. London: His Majesty's Stationery Office, Adastral House, Kingsway, W.C.2. Price 2s. 6d. net.

Textbook of Thermodynamics. By Paul S. Epstein. London: Chapman and Hall, Ltd., 11, Henrietta-street, W.C.2. Price 17s. 6d. net.

A Hundred Years of Mechanical Engineering. By E. Cressy. London: Gerald Duckworth and Co., Ltd., 3, Henrietta-street, W.C.2. Price 15s. net.

Protective Films on Metals. Second edition. By E. S. Hedges, M.Sc. London: Chapman and Hall, Ltd., 11, Henrietta-street, W.C.2. Price 21s. net.

A Hundred-year History of the P. and O. By Boyd Cable. London: Ivor Nicholson and Watson, Ltd., 7, Paternoster-row, E.C.4. Price 10s. 6d. net.

Magnesium and its Alloys. By J. L. Haughton, D.Sc., and W. E. Prytherch, M.Sc. London: His Majesty's Stationery Office, Adastral House, Kingsway, W.C.2. Price 2s. 6d. net.

Britain in Danger: An Examination of Our New Navy. By Captain Bernard Acworth, D.S.O., R.N. London: Eyre and Spottiswoode (Publishers), Ltd., 6, Great New-street, E.C.4. Price 8s. 6d. net.

THE INSTITUTE OF WELDING.—On Tuesday last, September 21st, the first annual dinner of the Institute of Welding took place at Grosvenor House, Park-lane, London, W.1. In the absence of the President of the Institute, Sir Alexander Gibb, the chair was taken by the Vice-President, Sir William J. Larke. About 350 members and guests attended the dinner the principal guest being the Right Hon. Leslie Burgin, the Minister of Transport. After the loyal toasts had been proposed, Dr. Burgin proposed the toast of "The Institute of Welding." In his speech he said that governmental and official approval was given to the efforts made by the Institute in formulating welding standards and in promoting welding research work. Sir William Larke, replying on behalf of the Institute, said that the objects of the welding industry and the Institute of Welding were to promote the interests of the metal industries by design and practice. He was grateful for the approval given to the establishment of the small fund for welding research and for the encouragement given by the Defence Services. Sir William Larke then proposed the toast of "The Guests," and Mr. Handley Page responded on behalf of the guests, saying that the welding of light alloys was a problem which had to be solved before welded construction could supersede riveted construction in aircraft manufacture.

The Documentation Centre at the Science Library.*

By S. C. BRADFORD, D.Sc., Keeper of the Science Museum Library, London.

A DESCRIPTION of the Science Library and its Information Service may be of interest as an illustration of the action of those forces, which have moulded the growth of library services in the past and must determine their development in the future, because the comprehension of these forces is essential to their intelligent application.

Like may other large general libraries of science, the Science Library originated in a comparatively small specialist collection of books, *i.e.*, the private library of an eminent geologist, Sir Henry de la Beche, who gave his library to the British nation in 1843 to form the nucleus of a library for the use of the officers of the Geological Survey and Museum. When the Government School of Mines was founded in 1851, the Library was gradually developed to serve the needs of that Institution and became a general library of science, unrivalled of its kind, containing works on geology, palæonotology, mineralogy, mining, metallurgy, natural history, chemistry, physics, and allied sciences from the earliest times. Subsequently, when the science teaching of the Department of Science and Art was reorganised in 1882, this Library, with the exception of books on geology which were needed for the immediate use of the Survey, was transferred to South Kensington, where it was amalgamated with the works on science in the Educational Library to form the Science Library of the South Kensington Museum. In 1883 the number of volumes was estimated at 44,000. By 1908 the Library had grown to 105,000 volumes. In 1926 this number had increased to 165,000, while now, in 1937, the total number of potential bound volumes in the Library has reached 265,000, which are increasing at the rate of about 12,000 volumes a year.

Thus, in course of time, the Library has become a national central library covering all branches of science and technology. It is particularly rich in periodical literature, including sets of the transactions of societies, bulletins, monographs, reports and other publications of Government departments, experiment stations, observatories, research institutions, universities and scientific organisations, as well as independent journals, published throughout the world. Many of the older series are now very rare, or almost unobtainable. The total number of such sets is about 14,000, of which about 9000 are current.

By means of an elaborate organisation, which it would be wasteful to reduplicate in special libraries, the difficulties of ascertaining particulars of the publication of new literature, in all its various forms, on every branch of science, have been surmounted to a large extent. And, with the aid of this machinery, the Library is made as complete as possible, so far as its resources will allow.

This achievement represents merely the commencement of the task with which the conscientious librarian is confronted. It is imperative to bridge the chasm which stretches deep and impassable between the reader and the information lying hidden and inaccessible in the mountainous accumulations of the records of discovery and invention. To this end, the Library has acquired an exceptionally complete collection of those bibliographical publications of all kinds, both serial and separate, which contain references to the subjects of the individual articles in the periodical literature of the world. Many of these lists of references are unpublished compilations, contributed by commercial organisations or even by private individuals. In the aggregate, this collection constitutes a very extensive index to the contents of the scientific literature of all countries, comprising some forty million references.

By those who have had no practical experience of the use of libraries in connection with scientific research, the provision of such a collection of references might be conceived as making the complete fulfilment of the obligations of a scientific librarian. In the past, librarians themselves have inclined to this view. But the delusion could not persist in face of the demands made of libraries by modern scientific and technical research.

Since the earliest times librarians have been concerned to assist their readers in discovering the available information, which is relevant to their investigations. Endeavour is made to answer inquiries for lists of books or papers on special subjects.

In practice the use of a collection of bibliographies, extensive though it may be, is found to present grave difficulties. In the domain of science and invention these difficulties are aggravated, because the original information occurs in the form of articles, which are scattered in many thousands of periodicals. The mass of bibliographical material, which is intended to give access to this information, is entirely unco-ordinated. There is the greatest diversity of system, necessitating the separate study of each bibliography in order to grasp its method. The different publications cannot be amalgamated into one index, but each part of each volume of each bibliography must be searched in order to collect the information that has been indexed in a given subject. Information on one topic is hidden in bibliographies devoted to other branches of knowledge and no subject is indexed completely. The search in this inchoate mass is only less difficult than the task of ransacking the periodicals in which the original information is recorded.

Since the administrative staff of the Science Library possesses the highest scientific qualifications, the bibliographies prepared in this Library in answer to inquiry have come to be recognised generally as setting a high standard, and the growth of the information service has suggested the desirability of an exhaustive inquiry into the bibliographical position. Such an inquiry has been made by mathematical experts in the Library, and its results indicate the simplest way out of the present chaos.

The difficulties have arisen from the fact that most bibliographies have been designed without any understanding of the problem involved in indexing the scientific literature of the world. The need for indexes has been realised and they have been produced forthwith without any preliminary study of the position. It is impossible to deduce an adequate technique in such circumstances.

The resulting bibliographies are necessarily imperfect. The first essential to the production of a complete index to recorded information is to ascertain the facts.

The investigations undertaken in the Science Library have been laborious and they would have been well nigh impossible in the absence of such a large collection of material as exists in this Library. These researches show that about three-quarters of a million scientific and technical papers of value are published each year in about 15,000 periodicals,† while only about 280,000 of these articles are abstracted or indexed in the 300 periodicals that purport to include such bibliographical notices. As some of the papers indexed are not of the greatest importance, the number of good articles which are indexed is probably only about one-third of those published. The remaining two-thirds lie hidden in the thousands of volumes on the library shelves. The inevitable result is that a large percentage of present-day scientific work is mere repetition of previous work, which is often better done.

I would like to emphasise that these figures are based on a number of long investigations in different subjects and by different methods, all of which agree in giving the same results.

The reason for this deficiency of index references is not far to seek. It depends on the fact that, to-day, every branch of science is related to every other branch. Scientific investigators work no longer in water-tight compartments. A discovery made in one branch of science may be of importance in any other branch. Modern science is one and indivisible. It follows that papers of interest in connection with a particular investigation may occur in almost any scientific periodical and references to such papers in almost any bibliography.

There is a nucleus of periodicals that contain a large number of articles relative to the subject of inquiry. For example, on the subject of lubrication, the number of such periodicals is about twenty. These periodicals include, roughly, a hundred articles on lubrication in the course of a year.

Besides these periodicals, there is a group of journals, dealing with related or border-line subjects, which contain articles on lubrication. The number of such periodicals is about 120. These periodicals include in the aggregate about a hundred papers on lubrication each year, the rate of occurrence of papers in any one of the journals being about one a year.

Next to this group of periodicals there is a larger group of about 700 or 800 periodicals, devoted to less related subjects or apparently unrelated subjects. This group contains, in the aggregate, also about a hundred articles annually on lubrication. But the average rate of occurrence in one periodical is only about one in seven years, and it may be as little as one in ten years.

Beyond this, there is a mass of thousands of periodical publications in which papers on lubrication may occur, but so infrequently that it is impracticable to pick them up. It is therefore impossible to estimate the number of such papers. They may well amount to as many as in the other groups. There is no criterion by which it is possible to determine whether a given periodical may contain an article on a particular subject. Nothing but search will show. And, if such articles occur, or do not occur, in a given periodical during a particular period, there is no guarantee that they will occur, or will not occur, during a different period. Scrutiny of the whole mass of periodicals is the impossible task which abstractors set themselves, when they attempt to gather together all the information on a particular subject. The cause of the deficiency of present indexes is now clear.

The same difficulty confronts librarians when they set out to make a collection of literature on a special branch of knowledge. As a result, each special library tends to grow into a general library. And this has been the origin of some of the largest general libraries of science. An analysis of the contents of some of the most important special libraries in the world has shown that their contents may be divided into three approximately equal sections comprising (1) the literature specifically devoted to their special subject, (2) an incomplete collection of the literature of related subjects, and (3) a miscellaneous and altogether inadequate collection of literature on general science and other branches of science, the books in the second and third groups being duplicated in many other libraries.

The Science Library is attempting, so far as its resources allow, to supplement the deficiencies of special libraries by creating a central reservoir from which they may draw the literature on cognate subjects and thus enable them to concentrate on completing their collections within their proper sphere.

Reverting to the theme of indexing the world's literature of science, we see that it is necessary to design each index as part of a whole. A simple count shows that the number of index references or abstracts published in a year is equal to the number of important papers issued. So that it would be possible, with the same expenditure of energy, to publish one reference or abstract to each scientific paper of importance, provided we could all agree to work together towards this end. When it is realised that the complete indexing of any particular subject is impracticable by the methods so much in vogue, this general agreement must be regarded as essential.

To bring about this general co-operation, the adoption of a standard system of classification is necessary, in order

* The World Congress on Universal Documentation held in Paris, Aug. 15th–21st, to which this paper was contributed, was the largest and most representative international bibliographical conference which has ever been held. It is satisfactory to record that resolutions were adopted unanimously supporting the International Institute of Documentation as the international controlling and co-ordinating body in matter of documentation. The way now seems clear for all those who have at heart the progress of science and invention to join in the organisation of a really complete index to scientific and technical papers by the collaboration of existing bibliographical undertakings using a standard system.

† The remaining periodicals included in the World List of Scientific Periodicals contain little matter of scientific importance.

that references prepared by every agency in every language may be compounded into a universal index. In addition, we must be prepared to give up the wasteful and inefficient method of picking out the articles on each special subject from the whole mass of 15,000 scientific periodicals and arrange that every article of importance in every periodical is indexed, irrespective of its subject.

This is not difficult to achieve. Periodicals devoted specifically to a particular branch of science would be allocated to the various indexing bureaux concerned with that subject, which should undertake to index every original article in the periodicals they undertake to deal with. The bureaux would abstract the articles definitely within their scope, at their discretion, and pass to a central clearing house classified titles of the articles not directly within their purview. The classification of the articles they abstracted would be done accurately by the experts working in connection with the bureaux. The classification of the articles, that were only catalogued, need not be detailed. The titles would be written on slips of uniform size, so that they could be arranged in classification order by unskilled staff at the clearing house. These titles would then be redistributed to the appropriate bureaux, according to the subjects indicated by the rough classification signs inscribed on them. In this way each bureau would receive notice of *every* article published which came within their scope, and this without the present wasteful expenditure of energy in scrutinising the whole mass of scientific periodical literature. On receipt of the catalogue titles, each bureau would decide which papers were worthy of abstracting. If possible, a classified index of the remainder should be published.

After allocation of periodicals on special subjects according to this plan, there would remain a number of periodicals, whose scope was too general to be undertaken by any specialist bureau. These periodicals would have to be indexed by institutions of more general scope, such as the large libraries of science possessing highly qualified personnel.

As a contribution to this scheme the Science Library indexes in its weekly bibliography of pure and applied science, every original article in a selection of some 150 scientific periodicals of more general scope. Abstracting agencies may rely on this bibliography to bring to their notice all papers within their scope occurring in these periodicals, of which a list is published.

There is at present one classification, and one only, that is sufficiently extensive and flexible for use in such a scheme. This is the Universal Decimal Classification of the International Institute of Documentation. In the Science Library all bibliographies that employ this system are cut up, mounted on cards, and incorporated in an index, which comprises, at the present time, two and a-half million references and is growing at the rate of 140,000 references a year. In such an index all references to one subject fall together under the same classification number, irrespective of source or language, and the time of search is reduced from days or weeks to a few moments. It may be worth while to record that the cost of the Subject-matter Index in the Science Library is only about £350 a year, including material and labour.

These references correspond to about 120,000 different articles out of the aggregate of 280,000 articles catalogued by all the world's publishing bibliographical agencies. The number of references is slowly and surely increasing. For example, in electrical engineering, some 10,000 references are classified by the Decimal Classification, as compared with a total of 9000 indexed by all the non-collaborating bibliographies. Thus we may look forward with confidence to the general adoption of the system.

It is unnecessary to enter here into a description of the Universal Decimal Classification, as this is now well known. The classification is kept up to date by the Commission of the Classification, which has its permanent secretariat at The Hague. New extensions and modifications are issued as required by the scientific institutions which use the Classification.

It is important to notice that the methods that have been adopted by the International Institute of Documentation for the realisation of a complete index to recorded information depend on the collaboration of existing self-supporting bibliographical undertakings, which have arisen to meet definite needs. By adopting the Decimal Classification the bibliographies they publish become part of the universal index. No additional expense is involved, and the progress of the movement as a whole is independent of the continued existence of any particular individual agency. Thus the work of the Institute has continued to grow from year to year.

It is necessary to express an apology for the length of the foregoing remarks. They provide but a brief *résumé* of the principles on which the Science Library Information Service has been founded. I may conclude with a very short description of that service.

By association with the British Society for International Bibliography, the information service is recognised as the international documentation centre for science of the Institut International de Documentation. The Information Service is based on the conception of a comprehensive library, complemented with a complete index and controlled by a scientific staff. The ideal is necessarily difficult to attain. But progress towards it has been substantial. The answers to inquiries range from short lists of books to comprehensive bibliographies. The bibliographies resulting from these inquiries are mimographed, and issued in the Science Library Bibliographical Series. In the course of a year these bibliographies comprise about 3000 references. The Weekly Bibliography of Pure and Applied Science contains notices of the accessions to the Library, together with references to the original articles in about 150 selected scientific periodicals of general scope. This bibliography comprises about 10,000 articles during a year. In addition to these two main series, three quarterly bibliographies of special subjects are compiled. These are (1) current bibliography of applied geophysics, (2) quarterly bibliograph of lubrication, and (3) quarterly bibliography of experiment tank work. An English abridgment of the Decimal Classification is issued under the title "Classification for Works on Pure and Applied Science in the Science Museum Library," third edition, price 5s.

Aircraft Engines.*

By A. N. TROSHKIN.

SURVEYING engine developments reveals no outstanding feature that might be called revolutionary, but rather the achievements made have been the result of numerous detail advances in design and materials. Changes that have improved engine characteristics have, in most cases, been due to application of designs and ideas which heretofore could not be put into practice because of limitations in materials and shop technique. All advances that have been made can probably be classed under the general headings of fuel and design. Fuel and engine developments are so closely allied that improvements in economy, power, or specific weight can usually be attributed to better fuels as well as improved design.

HIGH OCTANE FUEL.

Development of higher octane fuels has probably been one of the most important contributions to the aircraft industry by increasing engine power, without increasing the displacement, and with a decrease in specific weight. Prior to the development of 100 octane fuel, full-throttle operation at sea level conditions with highly supercharged engines was impossible without entering the detonation zone due to high compression pressures and the type of fuel. With this new fuel, increases in power and also the operation of highly supercharged engines at open throttle at sea level without danger of detonation was made possible, providing, of course, that sufficient cooling was available to prevent excessive temperatures of the head at this high power output per cylinder. Operations with this new fuel have shown that an increase of over 30 per cent. in power could be safely gained over that formerly obtained with 87 octane fuel in the same engine, with only a slight increase in weight due to the greater stresses imposed on the engine with the power increase.

Possible future importance of the higher octane fuel to the operator can be better realised from the tests conducted by Raymond W. Young, of the Wright Aeronautical Corporation, in which the results indicated that fuel consumptions as low as 0·34 lb. per horse-power hour could be obtained in the cruising range without excessive cylinder temperatures by using 100 octane fuel. This represents a saving of approximately 20 per cent. over the best economy obtainable with Army 92 octane fuel.

A new method of obtaining high octane fuel has been proposed by L. H. Kimball, of the Fuel Development Company, and is at present in use by some airline operators. A blend of aniline and alcohol, known as "Anilol," is used as an anti-knock compound, and is injected into the carburetter in controlled quantity to give the desired octane rating to the fuel used. The injection valve can be linked with the throttle to give an automatic increase in octane rating of the fuel with increased power. It cannot be added to the gasoline in the tank because it is not miscible with gasoline. At present Anilol is used with gasoline that has a 2·5 c.c. lead content, but it can be used in unleaded fuels with equally good results. This latter point is of great interest, since elimination of leaded fuels would solve many maintenance problems that are traceable to the lead compounds.

FUEL CONSUMPTION AND POWER CONTROL.

Although the engine's physical make-up has permitted extremely low fuel consumption, maintaining it under extremely variable atmospheric conditions of operation became problematical. In a survey covering numerous trips by various pilots over the same route using manual mixture controls, results indicated a variation in fuel consumption between pilots of as high as 30 per cent. Until the present, mixture control was maintained manually by the pilot. Fuel-air ratio would be gradually increased until the tachometer showed a slight drop in revolutions per minute, and then would be richened slightly to regain the lost speed. This would indicate maximum power at minimum fuel consumption. Some pilots were too anxious to operate at minimum fuel consumption and tended to enter a field of excessive leanness; others, with an eye towards low temperatures and high power, gravitated towards extremely rich mixtures; either case resulting in higher operating costs in maintenance or fuel. Even unintentionally, the pilot would enter extreme mixture conditions because he was occupied with the other hundred-odd instruments and controls that require his attention in flight. Secondly, these difficulties due to fuel consumption were further increased with the introduction of the constant speed propeller. Constant speed operation no longer gave the pilot a tachometer mixture check, since no matter what the power output or mixture was, the speed remained the same within a limited range. As the engine power dropped, the propeller pitch automatically decreased to maintain constant operating speed.

Tied up closely with the mixture control problem was that of restricting the power output at any altitude to the maximum allowable. Engines were now supercharged to develop rated sea level power at altitudes of 7000ft. or more. Unless the throttle was carefully set, the possibility of exceeding the rated horse-power at altitudes below the rated one was always inevitable. This power output has been usually checked by carefully controlling the throttle to maintain a manifold pressure that would not permit exceeding the rated power, but here, again, with the great responsibilities and numerous controls requiring the pilot's attention, results obtained with manual operation were never satisfactory.

In an effort to overcome this condition, various types of automatic power and mixture control were developed. That discussed by Beardsley,† before the Society of Automotive Engineers, operates on the principle of maintaining a constant density and temperature below the carburetter by automatically adjusting the volume of preheated air taken into the carburetter scoop and an automatic restricting flap valve at the scoop that limits the flow of the air into the carburetter and thus maintains the density at the equivalent of that at the altitude for which the engine is rated.

In addition to an automatic device of this type, a visible check on the mixture is always desirable. The majority of transport ships therefore use a Cambridge or Breeze exhaust analyser as standard equipment, to which the pilot can refer from time to time as a check on the operation of the automatic control.

Reports from air transport maintenance departments indicate that the time between overhauls which has risen from 300 to 600 hours, can be traced to a large extent to the use of automatic controls.

PREVENTING ICE FORMATION IN THE CARBURETTER.

In line with power output and mixture control, something might well be mentioned about developments in carburetter de-icing, long a difficult problem to air transport operators as has been de-icing of propellers and wings. Many unexplained accidents in the past undoubtedly resulted from icing conditions in the carburetter, and only recently has the importance of this type of icing been realised. Icing in general has always been a problem to the aircraft operator, but formations in the carburetter are not visible, and therefore power losses or failure has rarely been attributed to icing until the mechanics of carburetter icing were fully realised. This condition of the carburetter, unlike icing of the wings or propellers, was not confined to winter operation, but could and did occur even in atmospheric temperatures as high as 60 deg. Fah., provided the proper conditions of humidity and temperature drop in the venturi were encountered.

Perhaps an explanation of this phenomenon would not be out of order. A certain percentage of fuel leaving the jet vaporises as it travels through the venturi and throttle section. This vaporisation requires heat which is drawn from the surrounding air, causing a temperature drop as much as 28 deg. or 30 deg. Fah. If, at the same time, the humidity at atmospheric temperature is such that cooling to freezing increases the humidity beyond 100 per cent., precipitation of excess moisture will occur. Condensed vapour will mix with the gasoline in minute quantities, because the water tolerance of gasoline is low, and the remainder of the water will remain unmixed. At low temperature water adhering to the venturi and butterfly will freeze, and as the process is continuous, layer after layer is built up so that the opening at the venturi and the butterfly is greatly reduced, causing a serious loss in engine power. Ice formation is rapid, and in some cases only a minute or two elapses before engine power is seriously effected. The obvious solution of this condition is preheating intake air to temperatures that will maintain temperature in the venturi above freezing. High temperature should be maintained at all times since much more heat is required to remove the ice than to prevent it. Use of a preheating device has introduced difficulties due to corrosion of the preheating tubes by exhaust gases, although recently various transport companies have been using rings of Iconel metal, which they claim have been satisfactory. Other disadvantages that are likely to be encountered are loss of volumetric efficiency and possibility of entering the detonating zone as a result of high intake temperatures.

These particular disadvantages can be successfully eliminated by injecting alcohol at the venturi or using alcohol-blended fuels, both of which are extremely effective in ice prevention or elimination. Tests made by the author at the Daniel Guggenheim Laboratory on Callis alcohol-blended fuels successfully demonstrated that a period of less than a minute was required to eliminate entirely ice formations which had lowered the engine speed from 1800 to 1000 r.p.m. Air would have to be preheated to between 60 deg. and 77 deg. Fah. above that at which the formation occurred to obtain comparable results with heat. Automatic alcohol-injection systems, where the alcohol is injected into the carburetter at the venturi from an alcohol tank, have given similar results.

Besides alcohol and gasoline, Callis alcohol-blended fuel contains a stabilising agent which use increases the water tolerance of the mixture or the quantity of water that the fuel can absorb without separation occurring. Another interesting point is that the stabilisers used by Dr. Callis will make mixtures of aniline and alcohol miscible in gasoline, which should open a new field for Anilol as an anti-knock compound.

A recent addition to the de-icing field is the Chandler-Groves non-icing carburetter, a somewhat radical departure from conventional types, which is claimed to eliminate completely any icing difficulty without recourse to blended fuels or heat. It has other unusual constructions which deal with fuel flow and action under violent manœuvres, but ice elimination is by far the most interesting feature. The carburetter is designed with two modified cylindrical sectors that are located on either side of the main jet, and because of their shape provide the venturi effect required at the jet and the throttle control desired. Basically, the fixed venturi and throttle valve in the standard carburetter are replaced by a flexible venturi in the Chandler-Groves which does the work of both devices. Under this arrangement, fuel leaves the jet and encounters no valves or restrictions within the carburetter, as it does in the standard type, and little heat can be absorbed by the vaporising fuel from the carburetter proper, thereby reducing or eliminating any icing possibilities. Should conditions require, the throttle-venturi sectors can be readily heated, but in accordance with the published data, this is not necessary. The carburetter has, to date, undergone some 2000 hours of testing on high-powered engines with satisfactory results.

DAMPING TORSIONAL VIBRATION.

Much has often been said concerning the serious torsional vibration existing in the radial engine, and not until recently has the problem been given enough attention and thought to provide a solution. Engineers of the Wright Aeronautical Corporation developed a dynamic damper that has reduced periodic torsional vibration to the minimum. This development represents, without question, one of the most valuable contributions to aircraft engine design in many years, and has been obtained without adding any weight to the engine, which, in itself, makes this advance all the more interesting. Also, the system

* The American Society of Mechanical Engineers, October, 1936. Condensed.

† "An Automatic Power and Mixture Control for Aircraft Engines," by G. E. Beardsley, Jr., S.A.E. "Transactions," Vol. 30, 1935, pp. 301–306.

does not depend upon conversion of energy as in friction dampers.

In principle, the dynamic damper is a pendulum mounting for one crankshaft counterweight instead of the conventional rigid mounting. This pendulum action is accomplished by mounting a counterweight having the mass necessary to balance the engine in such a manner that it can vibrate through a small angle when disturbed. The counterweight is supported upon two rollers which are loose in holes both in the crank cheek and counterweight. This makes the assembly equivalent to suspending the counterweight from the cheek by two links. With either type of suspension, all points of the counterweight move in a circular path, and the counterweight as a whole has a parallel motion, behaving as a simple pendulum.

Stops are provided to limit the counterweight's motion during sudden accelerations. These stops are arranged to permit a motion which is considerably in excess of that required for complete damping at any speed. In normal operation therefore the counterweights are never sufficiently disturbed to strike the stops. When the counterweight is displaced, the restoring force is centrifugal and therefore varies with the square of the revolutions per minute and the damping effect increases with the speed as desired. The damper's period is designed to be $4\frac{1}{2}$ times the crankshaft speed, and is equal to that of the power impulses in the nine-cylinder radial engine thus smoothing out the torsional oscillations that are ever-present in rigid counterweight engines resulting from torque variations. Use of the dynamic damper has been estimated to have smoothed out the Wright engine to give an equivalent torsional oscillation of an eighteen-cylinder engine of equal total displacement.

A system of this type is independent of the crankshaft and propeller vibration characteristics, and is dependent only on the torque characteristics of the engine. Therefore, it can be used without modification on either geared or direct drive engines of the same type.

Choice of Materials Affects Engine Construction.

Effect of materials on engine construction, although not as spectacular as the mechanical and fuel developments, has been of utmost importance in securing weight reduction, increased power, and longer life of present-day engines. Last year's most outstanding trend has been increased application of magnesium alloy forgings and castings in low stress sections, such as cover plates, housings, and some crankcase assemblies. Not so many years ago magnesium alloys were regarded as so unstable and corrodible that they were not believed to be dependable for engine parts. Development of fluxes having sufficient viscosity to protect molten metal and which could be kept out of the final casting and improved foundry technique have done much to reduce these unfavourable characteristics. Stability against salt corrosion has been solved satisfactorily by dichromating the surface. Physical characteristics of magnesium are generally lower than in aluminium alloys, but these deficiencies are somewhat balanced by its low specific gravity which is approximately 65 per cent. of the other. Ease of machining magnesium, as compared with aluminium serves to reduce manufacturing cost, even though the material's original cost may be higher. Through proper design and application of magnesium alloys savings of approximately 30 per cent. over aluminium alloys can be obtained. Use of magnesium alloys will probably increase with a better understanding of their qualities and recent improvements.

Stellite on the faces has increased valve life tremendously. It has been welded to the valve face, thereby producing a hard surface. Working against a seat of silicon-chrome-tungsten steel, both valves and seat are practically immune to pitting or corrosion. This is also effective in reducing the pounding-in of the valve to the minimum. Improvements in valve lubrication as well as materials have increased valve life from 800 hours to as high as 2000 hours in high-powered engines.

Nitriding steel cylinder barrels has contributed materially toward an increased period of usefulness. The process requires exposing the barrel in an oven filled with ammonia gas and maintaining a temperature of 950 deg. Fah. for forty-eight to seventy-two hours, depending upon the depth of hardening required. The hardness obtained is approximately 1000 Brinell.

These outstanding improvements as well as numerous changes in composition, heat treatment, and the like have contributed greatly, both to decreased weight and to lessened maintenance problems.

Probable Developments in the Future.

Combining these individual improvements in a single unit has made large increases in power output and dependability possible in the modern engines. Improvements already made have indicated in which direction future gains in characteristics might be expected, and, as always, have also shown probable difficulties to be encountered.

Increased supercharging which is inevitable with future advances in power, will make the problem of manifold temperatures important. Some effective method of cooling the air after it has been compressed through the supercharger will have to be devised to avoid detonation from high intake temperatures and also to increase the volumetric efficiency of the unit. Perhaps finning the supercharger case and also locating the unit in the nose section to obtain maximum cooling may be the answer. Whatever the solution, the problem will prove to be important. Demand for high-altitude operation will require incorporation of an altitude booster supercharger, which will probably bring about a return of the exhaust turbine unit. This type is satisfactory and efficient for high-altitude operation.

High-speed geared engines may be another method of increasing power output without any great addition in weight. This is theoretically an ideal solution, since power does vary with speed. Practical problems of gear losses, vibration, materials, and piston velocity *versus* rate of combustion must be solved before any great increase in speed can be expected in high-powered engines. Although even at present various individual designers and engine companies behind "No Admittance" doors are experimenting on high-powered engines at speeds ranging as high as 5000 r.p.m., results of this work will not be evident until the designs and test data are released.

Use of 100 octane fuel throughout the operating range will be prevalent for reasons already covered. Further improvements in fuels, with perhaps the development of higher octane fuels for application with higher compression or manifold pressures than is at present possible, undoubtedly will also be made.

Engine noise will become more and more important in the future. At present, passenger comfort has been secured by soundproofing the cabins. Whether or not increases in power and in the number of ships in the air will make the noise problem one in which the comfort of the public may be important, is a subject for speculation. Some work is being carried out on aircraft engine mufflers. The effectiveness of no one unit has been presented as yet, but perhaps next year may see an efficiently muffled aircraft engine.

On the whole, much apparently will have to be done before single power units of 1500 H.P. or more can be developed which will give the dependability and life of the present production engines. Perhaps radical changes in design and materials will have to be made in reaching out for the higher power, but without question the designers, with all the ingenuity and skill that they have already shown in reaching the present stage, will likewise be able to overcome the future obstacles as they present themselves.

Engineering Notes from China.

(By a Far-Eastern Correspondent).

Capital Goods in Demand in the Far East.

Whatever form the final settlement of the present difficulties may take, the result must be an increased demand for capital goods in China. It is unlikely that the very large trade interests of Great Britan in North China will be allowed to lapse, but even if that did take place, the reconstruction work in other parts of China, if properly planned and financed, would keep the workshops of the highly organised industrial countries busy for many years. And, whatever may be our views about the rights and wrongs of the present conflict, it would be unfair to overlook the immense amount of work that Japan has provided in the past for British engineering firms. Nor is it unlikely that, if Japan does conquer North China and rule that huge area, she will be able to provide all of the engineering equipment essential for its rapid economic development. Five major electric power concerns in Japan a few months ago combined to form the North China Electric Power Industry Company. A British firm, the Tientsin Native City Waterworks Company, Ltd., recently purchased the electric power plant in the former German concession in Tientsin. It is obvious that electric power is increasing in demand in China. Mechanisation has made more progress during the last ten years than in all the forty centuries of the nation's history. It is practically certain that a result of the present trouble will be to accelerate the rate of mechanisation in China. British manufacturers have won a reputation for engineering equipment that will enable them to obtain good orders.

Keen Competition.

There is considerable competition with Japanese makers of textile machinery in China. The large Japanese mills in Shanghai have perhaps created an impression amongst the Chinese that Japanese machinery is more efficient than that made in Britain. It is also possible that the tenders submitted by Japanese are very much lower in price. However, it is noticeable that the Ching Foong Cotton Mill, Wusih, gave an order to the British firm for 450 Hattersley looms and seven Pirn winders. This contract was worth 250,000 dollars. Another cotton mill in Wusih has recently placed an order with the same British firm for 200 looms, valued at 85,000 dollars. It was unfortunate that yet another order from Wusih for English looms, valued at 200,000 dollars, could not be accepted by Hattersleys, as they stated that their works were fully booked up and that no more deliveries could be promised until next year. The contract had therefore to be cancelled. It is, however, inevitable that the recent actions of Japan in North China will have its effect upon Sino-Japanese trade, especially along the Yangtse Valley and in South China. Chinese industrial leaders retain the old Chinese characteristics, of which personal pride is one of the most outstanding. They are disappointed with the British and American Governments, but they will retain long memories concerning the humiliations which they feel because of the demands made by Japan. They will proceed with industrial enterprises in those parts of China controlled by their own Government. A result of this conflict will be to stimulate a demand for capital goods in China.

Progress in Power Production.

During 1937 there have been numerous contracts in China for the supply of British machinery for cotton, worsted, and flour mills. In all cases electrical equipment has been demanded and several firms have obtained valuable orders. The chief centres affected by these extensions have been Shanghai and Wusih and Hankow. In many cases the mills have their own generating plants, which are usually from about 3000 kW to 5000 kW capacity. A power station of this type was recently equipped with British machinery to supply power for the Lun Chong Cotton Mill, Shanghai. This mill is owned by the China Printing and Finishing Company, Ltd., one of the largest textile concerns in the Far East, possessing a number of factories for bleaching and dyeing. The new Lun Chong Mill is for the manufacture of grey cotton cloth, for which material there is an enormous demand in China. The company can now produce the finished goods, bleached, dyed and printed, manufactured from the raw cotton. The new mill employs over 2000 people and has 1150 looms and 50,000 spindles. The complete contract for the electrification of the mill, together with all of the plant for the power station, was obtained by the China subsidiary of the G.E. Co. (England). The motors in the mill total 214 in number and 2500 H.P. The present plant in the power plant consists of two 2000-kW turbo-alternators and one of 100 kW, with provision for another 2000-kW set. There are two humidifying plants to maintain the correct relative humidity of the air as required for spinning and weaving. The motors for the humidifying plants have a total capacity of 125 H.P. This is a typical size of power plant for mills in China. In Shanghai there is a big demand for power by the public supply company by mills and other industries. In twenty-one years, 1915-36, the output of the Shanghai Power Company jumped from 5 million B.O.T. units to 735 million units, and it continues to increase. There are other public electricity supply companies in Shanghai. It is estimated that Shanghai consumes about seven million tons of coal per annum. To generate 753 million units in 1936 the Shanghai Power Company used 563,504 tons of coal. There has been a notable increase in the production of town gas by the Shanghai Gas Company (managed by a British board of directors and technical staff) in recent years. Incidentally it may be mentioned that at present the only centres in China with a town gas supply are Shanghai, Hong Kong, and Dairen. The latter city is under Japanese control; British equipment and enterprise has enabled Shanghai and Hong Kong to obtain the advantages of this form of fuel. Although there are few gas plants in China, the demand for this fuel will increase as mechanisation of industry develops in China. It was inevitable that, in the early stages of the transformation, the results of mechanisation would be a demand for electric power. Notable extensions in power plants have taken place in many cities in China, especially in Shanghai, Hankow, Canton, and Nanking.

Machinery Imports to China.

The Chinese Maritime Customs services uses the gold unit for the collection of duties. In millions of this unit the relative value of the imports of the following materials to China from Britain and Japan for 1936 are given:—Iron and steel, 8·2 and 7·3; machinery was not so favourable to Britain, the figures being 5·1 and 7·4; vehicles were more favourable, being 4·9 and 2·3; vehicles from the U.S.A. were listed in value at 5·7, but machinery was 3·1, while iron and steel was 5·7. Very big items on the import list of goods from the U.S.A., and absent from the import lists of both Britain and Japan, were (1) gasoline, 3·3 million gold units; (2) liquid fuel, 1·8 million gold units; (3) lubricating oils, 2·8 million gold units. The Asiatic Petroleum Company, Ltd. (Shell) does a very large trade in liquid fuel, gasoline, and lubricating oil in China, and employs a very considerable number of public school and university men from Britain, but it imports chiefly from Borneo and other centres which makes it difficult to determine from the Chinese Customs figures the value of its trade. It is evident, however, from the above figures that the demand in China is for goods concerned with mechanised industry. British cotton piece goods, which for years headed the list of imports, fell to a value of 1·4 million gold units in 1936. In considering the figures for Japanese imports it must be remembered that the Chinese Customs authorities and various British interests in China have made vigorous protests concerning the great amount of smuggling of Japanese goods that has been going on for some time in North China, so that it is a fair inference that iron and steel and other materials from Japan entered China without being reckoned in the return published by the Maritime Customs. If a result of the present trouble is to reduce or eliminate smuggling of Japanese goods into China, British firms will benefit.

In the meantime manufacturers must remember that China is a country of enormous area and that the main fact to be remembered concerning the Far East is the determination of the Chinese political and industrial leaders to develop the natural resources of the country. If Dr. Kung has been able to raise foreign loans for the purpose a considerable portion of the sums will be spent on capital goods. Financial aid from other countries may not be readily offered to Japan unless she is willing to co-operate with the other nations in the economic development of China.

AMERICAN BIO-FILTRATION SEWAGE WORKS.

Reference was made some months ago to a new process of sewage treatment termed "bio-filtration," and a plant having a capacity of a million gallons daily has been put in operation for the treatment of strong sewage from a hospital in California. The process provides recirculation of the sewage at high rates of flow through a filter of loose rock, and is said to combine the advantages of the activated sludge process and those of the trickling filter. Detention settling tanks and separate sludge digestion facilities are provided, and the purified effluent is used for irrigation purposes. Of sufficient capacity to handle the domestic sewage from a population of 7000 patients and employees, it has to provide also for a considerable volume of dairy and laundry wastes. Estimates showed that the bio-filter works would have a lower first cost than trickling filter works, and a lower operating cost than activated sludge works. By-passing the clarified sewage through the rock filter repeatedly, instead of once, as in the case of a trickling filter, this bio-filter can work at as much as ten times the rate per cubic yard of filter that is practicable with a trickling filter. Biologic oxidation of the organic matter takes place in the filter bed, with secondary reactions occurring during the passage of the recirculated flow through the detention tanks. By means of the return of sludge from these tanks it is possible to activate the biologic condition of the filter, if this should be required by the volume or concentration of the sewage. From the primary tanks the sewage is pumped to the filter, where it is applied by revolving perforated pipes. The effluent from the filter goes to the secondary or detention settling tanks, from which some goes back to the filter and the rest to a storage pond. The filter is 85ft. in diameter, with a base of pre-cast concrete grating which is covered by a bed of broken stone 3ft. deep, composed of broken stone of $1\frac{1}{2}$in. to $2\frac{1}{2}$in. size.

L.M.S. School of Transport.—The foundation stone of the London, Midland and Scottish Railway Company's School of Transport at Osmaston Park, Derby, was laid on Wednesday last by Sir Josiah Stamp, chairman of the company.

Markets, Notes and News.

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quotations are f.o.b. steamer. A comprehensive list of the prices of materials mentioned below will be found on the next page.

The Continental Steel Position.

British consumers are benefiting from the decline in the Continental steel export trade, since larger quantities of semi and finished steel are reaching this country. At the moment, whilst there is a good home demand in Belgium and some call for shipbuilding steel from Scandinavia, the bulk of the export business now being executed is for Great Britain. One result has been that the British re-rolling works are getting larger supplies of Continental billets and this has enabled them to maintain a slightly better rate of operations. In some cases, however, complaints have been heard by firms who have previously always used British steel that the Continental material does not meet their requirements. The chief feature of the situation in Belgium and Luxemburg is the easiness which has developed in the pig iron department. A few weeks ago it was almost as difficult to buy Continental as British pig iron; but now general surprise is expressed at the quantities of the former which are being offered. The British import duty of 12½ per cent., however, makes the price higher than the home-produced material, and so far as can be gathered little has been bought by British consumers. Fair quantities of steel appear to have been offered from sources outside the Cartel, and the Belgian re-rollers have shipped moderate tonnages of bars and sections to this country at prices which are considerably in excess of the official figures to which the Cartel works have to adhere. The German steel makers can afford to take as complacent a view of the situation as the British makers, since their home demand continues to absorb very large quantities of steel. In fact, consumers there are rationed as in this country, and in August only 70 per cent. of the tonnage included in any order could be accepted by the manufacturers. This proportion has been slightly increased for September to 75 per cent. The French steel works are not so well off for orders as other members of the Cartel; but lately they are reported to have secured a fair tonnage of business. The unfortunate situation ruling in that country as regards labour, however, militates against consumers buying freely from French works owing to the possibility of delays in deliveries. The fighting in the Far East is causing some disturbance to the Continental steel trade, although it is said that only about 3000 tons of finished steel is due for shipment to China from Germany. Considerable quantities, however, have to be shipped from other countries, and enough has been diverted to different markets to upset this branch of the export trade.

The Pig Iron Market.

A more comfortable situation exists in the pig iron market than for many months past, particularly in the foundry department. So far as steel making irons are concerned, the immediate situation is satisfactory, but some nervousness is felt with regard to a possible shortage of supplies towards the end of the year. Business in foundry iron has not been heavy, and the easiness in the market is chiefly noticeable in the better deliveries against running contracts and a reduction in the accumulated arrears. There is practically no surplus output for sale this year and there is an increasing reluctance on the part of makers to quote on business for next year. The situation as regards coke is too uncertain and the incidence of the higher railway rates has yet to be ascertained, whilst the question of possible wage advances is also a factor which must be taken into consideration. Business has been transacted for delivery in the first quarter of 1938 on prices ruling at the date of dispatch terms, but this is not regarded as a very satisfactory solution of the price problem. On the North-East Coast there is still only one furnace producing Cleveland foundry iron and the quantities available for the market are restricted. The makers are not interested in forward business and are devoting their energies to overtaking arrears against old contracts and to meeting consumers' current requirements. In the Midlands the market has a distinctly healthier appearance, although there is little chance of putting through any new business. The slackening in the demand from the light castings section of the market, however, has enabled producers to pay more attention to the needs of the engineering foundries, and the arrears of deliveries due to merchants as well as to the consuming branches of the trade have been eaten into. On the other hand, the producers have no stocks and are apparently unable to build up any reserves, although some of the consumers are reported to have put by a small tonnage for an emergency. In Scotland an additional furnace has been blown in on foundry iron, the number in operation now being one on basic, seven on hematite, and eight on foundry iron. New business in hematite is difficult to arrange, although the position has become easier as a result of the resumption of ore shipments from Spain. The makers are now in a position to give long overdue attention to contracts with overseas consumers entered into some time ago.

The Midlands and South Wales.

There is no easing in the stringency arising from excess of demand over supply in the Midland steel market. The constructional engineering firms continue to experience great difficulty in obtaining their requirement of joists, sections, and plates, in spite of the arrangement which has now been in operation for some weeks for giving precedence in rolling to consumers' urgent requirements. It is understood that further discussions have taken place between the engineers and the steel makers and that a suggestion is under consideration that the situation might be helped if the works concentrated upon longer rollings of the sizes most in use. The constructional engineers, however, view this proposal with some alarm, as they fear that work might be held up for supplies of certain sizes if the steel works rolling programmes were simplified to an extent sufficient to make any real impression upon the situation. It is believed locally that the demand for Government work is likely to expand during the next few months and that it is already obvious that supplies of steel will be insufficient to meet both the defence requirements and the ordinary home demand. Imported steel has been distributed in the Midlands on a larger scale than for a long period, but the quantities available do not seem nearly enough to make up the gap between the demand and the supplies of British material. Promises, however, have been made that the supplies will be further increased during the next few weeks. The re-rollers in the Midlands are rather better off as regards deliveries of billets than for some months, but work at most establishments is still handicapped by short supplies of raw material. Colliery managements complain that they are not receiving as much steel as they require and are unable to place new orders for delivery this year. A certain amount of business has been reported in the renewal of expiring contracts. Quotations are unaltered at £11 10s. basis for light arches, £10 17s. 6d. for bridge rails, and £10 10s. for 5in. corrugated roofing bars. These prices will only rule until the end of the year. Great activity continues to prevail at the South Wales steel works and there is a steady and heavy demand from the tinplate works for sheet and tinplate bars. Export business in tinplates has declined slightly, but the demand on home trade account has expanded.

Scotland and the North.

With the exception of the light castings industry the whole of the Scottish iron and steel trades are actively employed. The steel works are making heavy deliveries of ship-plates and sections to the shipyards, and it is practically impossible to place new business excepting for delivery next year and then on indefinite terms. An arrangement, it is understood, has been arrived at between the shipbuilders and the steel makers on somewhat similar lines to that which is in operation between the steel makers and the constructional engineers. It is hoped that this scheme will enable the steel works to concentrate upon the production of the material most urgently needed by the shipbuilders. Lately there have been few new orders for ships placed, but it is expected that contracts will be given out this year for two 27,000-ton liners for the Pacific service, and tenders are now being prepared. The Scottish constructional engineering industry has sufficient work in hand to maintain active operations well into next year, but lately the contraction in new business has aroused some misgiving. Possibly this is due to the uncertainty regarding the prices which will rule after December 31st, when the position will again come up for review. In spite of the pressure exerted by consumers, there is still difficulty in obtaining urgent requirements, and the steel works will enter next year with a heavy unfilled tonnage on their books, a good proportion of which will be for delivery at the price ruling on the date of dispatch. The re-rollers are working upon practically day-to-day supplies of billets and are offered more business than they can accept in view of their present situation as regards raw materials. In the Lancashire district the stringency of the market remains acute and all consumers appear to be rigorously rationed. The shortage of shafting and large steel bars is very pronounced and up to ten months for delivery has been quoted by some makers. The pressure for supplies of plates is, if anything, increasing, but the works are reluctant to accept new business until some of the arrears in delivery have been worked off. The producers on the North-West Coast are busily employed and have enough work in hand to keep them occupied into the opening months of 1938. New business can only be accepted for delivery a long time ahead.

Current Business.

The L.M.S. Railway has placed orders for a total of 180 bolster truck vehicles, which have been distributed as follows:—The Fairfield Shipbuilding and Engineering Company, Ltd., thirty 50-ton bogie bolster trucks; Hurst, Nelson and Co., Ltd., Motherwell, thirty 20-ton double bolster trucks; Metropolitan Cammell Carriage and Wagon Company, Ltd., Birmingham, sixty 20-ton double bolster trucks; and C. Roberts and Co., Ltd., Wakefield, sixty 20-ton double bolster trucks. Dorman, Long and Co., Ltd., Middlesbrough, have secured a contract for the supply of steel work for the new R.A.F. aerodrome at Carlisle. About 10,000 tons of steel will be used in the girders and frames and the value of the contract is £27,000. A site of about 40 acres has been acquired by the Bristol Tramways and Carriage Company, Ltd., at Brislington, where it is proposed to erect new factories for the construction of motor buses and coaches and heavy oil engines. J. L. Thompson and Sons, Ltd., Sunderland, have secured an order for a 9000-ton steamer from Hall Bros., Newcastle-on-Tyne. The machinery will be made by the North-Eastern Marine Engineering Company, Ltd., Wallsend. The Clyde Lighthouses Trust has obtained permission from the Board of Trade to carry out special dredging of the Clyde within the next five years in preparation for the passage down the river of the sister ship to the "Queen Mary," now being built by John Brown and Co., Ltd., Clydebank. Fisher and Ludlow, Ltd., Birmingham, car body and pressed steel equipment makers, are negotiating for a site for a factory at Tile Hill, Coventry. The Trussed Concrete Steel Company, Ltd., announce that all steel for the company's Scottish undertakings will in future be supplied from the plant erected at the former Brandon Bridge Works, Motherwell, and will be of Scottish manufacture. A coastal motor tanker with a carrying capacity of 220 tons is being constructed for the National Benzole Company, Ltd., at Rowhedge, Colchester. The cycle business carried on by Dunford and Elliott (Sheffield), Ltd., steel manufacturers, has been bought by the Raynal Manufacturing Company, Birmingham. Toolmakers in Sheffield and the district have refused an order for entrenching tools for China, as they are too heavily booked to accept the business. The Department of Overseas Trade announces that the following tenders are open:—South African Railways and Harbours Administration: galvanised iron piping, screwed and socketed, ¼in., 2in., and 3in. in diameter; 2in. wrought iron piping, steam quality; and pipe fittings (Johannesburg, October 11th); Indian Stores Department, Engineering Branch: supply and delivery of machine tools, including lathes, drilling, boring and tapping machine, shaping machine, bolt and pipe screwing machine, hand punching, shearing and cropping machine, band saw, saw sharpening machine, smithy blower and positive type (Roots pattern) blower (Simla, October 6th); Montevideo, State Electricity Supply and Telephones Administration: supply and delivery of drill bits for drilling wood and metal (Montevideo, October 26th).

Copper and Tin.

Weak conditions ruled in the electrolytic copper market until mid-week when prices which had registered a substantial decline began to recover. It is scarcely surprising that, in view of the international, political, and financial situation, consumers have shown little confidence in the stability of trading conditions and the demand, which a short time ago gave promise of developing considerable activity, has become spasmodic. It might be supposed that the hostilities in the Far East and the rearmament programmes still being carried out in Europe would be a bull point in the market, but against this has to be set the fall in the franc and the continued weakness on Wall-street. The fact also that production at the moment appears to be in excess of consumption is an adverse factor in the situation, although there is a section of the market which believes that the expansion in industrial requirements will prove more than sufficient to take care of the output. There is no doubt that the present consumption of electrolytic copper is on a heavy scale, and if surrounding conditions were more favourable there would be little reason to fear any further recession in values. There seems, however, to be small likelihood of a definite improvement in the situation for the time being, and apparently the general view is that hesitating markets must be expected. The fact that consumers have lately shown more inclination to buy forward indicates that consumption is likely to be maintained, although by far the greater part of the business transacted has been for near delivery. In the London standard copper market prices have receded further and there has been a certain amount of bear selling, although the speculative account is not large. At times the market has shown resistance to the downward movement; but, on the whole, the tone has been weak. . . . Following active buying, largely on American account, trading in the tin market has developed a colourless appearance. The consumptive demand shows no signs of shrinking and supplies are by no means plentiful. With tin, as with most other metals, it is suggested that production is gradually increasing, but it seems probable that for the remainder of this year there will be no surplus of metal to weigh on the market. Much, however, will depend upon whether Bolivian shipments can be increased. Consumers on the Continent have shown more interest in the market than for some time. Early in the week this market shared in the general improvement in sentiment and prices recovered some of the lost ground. Apparently dealers took the view that the decline in metal values had been overdone and there was a fair amount of buying.

Lead and Spelter.

The shrinkage in lead prices continued until quotations touched the lowest point reached this year, after which there was a sharp reaction. The depression which had overtaken all metal markets and had arisen chiefly from outside influences appeared the principal cause of the relapse, since the demand for lead was well maintained. The decline in building is, of course, an adverse factor in the market position, but this has been more than discounted by the fall in price. A certain amount of bear selling, coming at a time when sentiment was distinctly weak, has also had an influence in causing values to drop. Apart from the lessened requirements of the building trades, the demand from the principal consumers has been on a good scale and the cable makers in particular continue to take good tonnages. It is pointed out that at the present range of values lead is the cheapest of the non-ferrous metals and that an upward reaction is overdue. Supplies, however, appear to be increasing and for the time being there is a tendency for the smaller consumers to take a rather bearish view of the market. Arrivals are well taken up by users, with the result that the contango rate remains narrow. . . . In common with other non-ferrous metal markets, spelter prices sharply receded; but early this week registered some recovery. At times the market showed definite signs of resisting the downward pressure, but the surrounding circumstances often proved too strong. There seems a likelihood that at around present prices spelter may be shipped to the United States, and it is probable that some transactions of this character have been entered into. The slump on Wall-street, however, has not been conducive to operations of this description. The view taken in the market is that the American requirements will have to be satisfied by purchases of European spelter. The shortage of spelter in America remains acute but the demand is principally for high-grade metal of which a similar scarcity exists in Europe. In fact, premiums of £3 or more have been paid for this description against the normal margin of £2. There has been fair buying by Russia and Japan, although latterly the Japanese Government appears to have restricted the issue of import licences. American figures give the production in the United States in August as 48,319 tons, the deliveries 50,643 tons, and the unfilled orders at the end of the month at 106,087 tons. The stocks of spelter had declined at the end of August to 11,227 tons.

Current Prices for Metals and Fuels.

Makers' official home trade prices, per ton, delivered buyers' stations. Joists as well as Sections and Plates are now subject to a rebate of 15s. to home users purchasing only from associated British Steelmakers.

PIG IRON.

	Home.	Export.
	(D/d Teesside Area)	
N.E. COAST—	£ s. d.	£ s. d.
Hematite Mixed Nos.*	6 2 6	—
„ No. 1	6 3 0	—
Cleveland—	*(D/d Teesside Area)*	
No. 1	5 3 6	6 2 6
No. 3 G.M.B.	5 1 0	6 0 0
No. 4 Foundry	5 0 0	5 19 0
Basic (*Less 5/- rebate*)	5 0 0	—
MIDLANDS—		
Staffs.—	*(Delivered to Black Country Station)*	
North Staffs. Foundry	5 6 0	—
„ Forge	5 1 0	—
Basic (*Less 5/- rebate*)	5 0 0	—
Northampton—		
Foundry No. 3	5 3 6	—
Forge	4 18 6	—
Derbyshire—		
No. 3 Foundry	5 6 0	—
Forge	5 1 0	—
SCOTLAND—		
Hematite, f.o.t. furnaces*	6 3 0	—
No. 1 Foundry, ditto	5 15 6	—
No. 3 Foundry, ditto	5 13 6	—
Basic, d/d (*Less 5/- rebate*)	5 7 6	—
N.W. COAST—	6 3 0 d/d Glasgow	
Hematite Mixed Nos.*	6 8 6 „ Sheffield	
	6 14 6 „ Birmingham	

* *Less 5/- rebate.*

MANUFACTURED IRON.

	Home.	Export.
LANCS. AND YORKS.—	£ s. d.	£ s. d.
Crown Bars	13 5 0	—
Best Bars	13 15 0	—
MIDLANDS—		
Crown Bars	13 5 0	—
Marked Bars (Staffs.)	15 15 0	—
No. 3 Quality	11 12 6	—
No. 4 Quality	12 2 6	—
SCOTLAND—		
Crown Bars	13 15 0	13 5 0
Best	14 5 0	13 15 0
N.E. COAST—		
Crown Bars	13 5 0	13 5 0
Best Bars	13 15 0	13 15 0
Double Best Bars	14 5 0	14 5 0
NORTHERN IRELAND AND FREE STATE—		
Crown Bars, f.o.q.	13 17 6	—

STEEL.

	Home.	Export.
LONDON AND THE SOUTH—	£ s. d.	£ s. d.
Angles	11 3 0	10 12 6
Tees	12 3 0	11 12 6
Joists	11 3 0	10 12 6
Channels	11 8 0	10 17 6
Rounds, 3in. and up	12 3 0	11 12 6
„ under 3in.*	12 0 6	11 0 0
Flats, under 5in.*	12 0 6	11 0 0
Plates, ¾in. (basis)	11 13 0	11 0 0
„ ⅝in.	11 18 0	11 5 0
„ ½in.	12 3 0	11 10 0
„ ⅜in.	12 8 0	11 15 0
Un. ⅜in. to and incl. 6 lbs. per sq. ft. (8-G.)	12 10 0	12 10 6
Boiler Plates, ¾in.	12 3 0	12 2 0
NORTH-EAST COAST—	£ s. d.	£ s. d.
Angles	11 0 6	10 12 6
Tees	12 0 6	11 10 0
Joists	11 0 6	10 12 6
Channels	11 5 6	10 17 6
Rounds, 3in. and up	12 0 6	11 12 6
„ under 3in.*	11 18 0	11 0 0
Plates, ¾in. (basis)	11 8 0	11 0 0
„ ⅝in.	11 13 0	11 5 0
„ ½in.	11 18 0	11 10 0
„ ⅜in.	12 3 0	11 15 0
Un. ⅜in. to and incl. 6 lbs. per sq. ft. (8-G.)	12 10 0	12 10 0
Boiler Plates, ¾in.	11 18 0	12 2 0
MIDLANDS, AND LEEDS AND DISTRICT—	£ s. d.	£ s. d.
Angles	11 0 6	10 12 6
Tees	12 0 6	11 12 6
Joists	11 0 6	10 12 6
Channels	11 5 6	10 17 6
Rounds, 3in. and up	12 0 6	11 12 6
„ under 3in.*	11 18 0	11 0 0
Flats, 5in. and under*	11 18 0	11 0 0
Plates, ¾in. (basis)	11 10 0	11 0 0
„ ⅝in.	11 15 6	11 5 0
„ ½in.	12 0 6	11 10 0
„ ⅜in.	12 5 6	11 15 0
Un. ⅜in. to and incl. 6 lbs. per sq. ft. (8-G.)	12 10 0	12 10 0
Boiler Plates, ¾in.	12 0 6	12 2 0

STEEL (*continued*).

	Home.	Export.
GLASGOW AND DISTRICT—	£ s. d.	£ s. d.
Angles	11 0 6	10 12 6
Tees	12 0 6	11 12 6
Joists	11 0 6	10 12 6
Channels	11 5 6	10 17 6
Rounds, 3in. and up	11 0 6	11 12 6
„ under 3in.	11 18 0*	11 0 0
Flats, 5in. and under	11 18 0*	11 0 0
Plates, ¾in. (basis)	11 8 0	11 0 0
„ ⅝in.	11 13 0	11 5 0
„ ½in.	11 18 0	11 10 0
„ ⅜in.	12 3 0	11 15 0
Un. ⅜in. to and incl. 6 lbs. per sq. ft. (8-G)	12 10 0	12 10 0
Boiler Plates, ¾in.	11 18 0	12 2 6
SOUTH WALES AREA—	£ s. d.	£ s. d.
Angles	11 0 6	10 12 6
Tees	12 0 6	11 12 6
Joists	11 0 6	10 12 6
Channels	11 5 6	10 17 6
Rounds, 3in. and up	12 0 6	11 12 6
„ under 3in.*	11 18 0	11 0 0
Flats, 5in. and under*	11 18 0	11 0 0
Plates, ¾in. (basis)	11 10 6	11 0 0
„ ⅝in.	11 15 6	11 5 6
„ ½in.	12 0 6	11 10 0
„ ⅜in.	12 5 6	11 15 0
Un. ⅜in. to and incl. 6 lbs. per sq. ft. (8-G)	12 10 0	12 2 6

IRELAND—F.O.Q.	BELFAST. £ s. d.	REST OF IRELAND. £ s. d.
Angles	11 5 6	11 8 0
Tees	12 5 6	12 8 0
Joists	11 5 6	11 15 6
Channels	11 10 6	11 13 0
Rounds, 3in. and up	12 5 6	12 8 0
„ under 3in.*	10 16 0	10 16 0
Plates, ¾in. (basis)	11 13 0	11 15 6
„ ⅝in.	11 18 0	12 0 6
„ ½in.	12 3 0	12 5 6
„ ⅜in.	12 10 0	12 10 6
Un. ⅜in. to ½in. incl.	12 3 0	12 5 6

* *Rounds and Flats tested quality; Untested 9/- less.*

OTHER STEEL MATERIALS.

Sheets.	Home. £ s. d.	Export. £ s. d.
11-G. to 12-G., d/d	14 15 0 ...f.o.b.	14 10 0
13-G., d/d	15 2 6	14 10 0
14-G. to 20-G., d/d	15 10 0 ...f.o.b.	14 15 0
21-G. to 24-G., d/d	15 15 0 ...f.o.b.	15 0 0
25-G. and 26-G., d/d	16 10 0 ...f.o.b.	15 15 0

South Africa, 24-G., Basis £15 0s., plus 3% on invoice value; Rhodesia, £15 10s.; Irish Free State, £16 10s., f.o.q.

The above home trade sheet prices are for 4-ton lots and over; 2-ton to 4-ton lots, 7s. 6d. per ton extra; and under 2-ton lots to 10 cwt., £2 per ton extra.

Galvanised Corrugated Sheets, Basis 24-G.—

Home.	£ s. d.	Export. Basis—	£ s. d.
4-ton lots and up	19 10 0	26-G. and heavier	18 15 0
2-ton to 4-ton lots	19 17 6	27-G. to 29-G.	19 15 0
Under 2 tons	21 2 6	30-G. and lighter	20 15 0

Export: India, £22 5s. c.i.f.; South Africa, £18 15s. f.o.b., plus 3 p.c. invoice value; Rhodesia, £19 5s. f.o.b.; Irish Free State, £19 10s. f.o.q.; General, £18 15s. f.o.b.

Tin-plates.

20 by 14 basis, f.o.b. Bristol Channel Ports, 25s. 0d. to 26s. 0d.

Tin-plate Bars, d/d Welsh Works, £7 15s. 0d.

Billets. 100-ton lots and over. 35 to 100 tons, 5/- extra; less than 35 tons, 10/- extra.

	£ s. d.
Soft (up to 0·25% C.), untested	7 17 6
„ „ „ tested	8 7 6
Basic (0·33% to 0·41% C.)	8 12 6
„ Medium (0·42% to 0·60% C.)	9 2 6
„ Hard (0·61% to 0·85% C.)	9 12 6
„ „ (0·86% to 0·99% C.)	10 2 6
„ „ (over 0·99% C.)	10 12 6
Rails, Heavy, 500-ton lots, f.o.t.	10 2 6
„ Light, f.o.t.	9 2 6

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	8/6 to 9/6 per lb.	
Ferro Tungsten	9/- to 9/3 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£24 5 0	7/6
„ „ 6 p.c. to 8 p.c.	£24 0 0	7/6
„ „ 8 p.c. to 10 p.c.	£24 0 0	7/6
„ „ Max. 2 p.c. carbon	£36 0 0	11/-
„ „ „ 1 p.c. carbon	£38 5 0	11/-
„ „ „ 0·50 p.c. carbon	£41 0 0	12/-
„ „ „ carbon-free	1/- per lb.	
Metallic Chromium	2/5 per lb.	
Ferro Manganese (loose), 76 p.c.	£18 15 0 home	
„ Silicon, 45 p.c. to 50 p.c.	£12 0 0 scale 5/- p.u.	
„ „ 75 p.c.	£17 0 0 scale 6/- p.u.	
„ Vanadium	12/8 per lb.	
„ Molybdenum	4/9 per lb.	
„ Titanium (carbon-free)	9d. per lb.	
Nickel (per ton)	£185 to £190 per ton.	
Cobalt	8/6 to 8,9 per lb.	

NON-FERROUS METALS.

(Official Prices, September 22nd.)

COPPER—		
Cash	£52 1 3 to £52 3 9	
Three months	£52 1 3 to £52 2 6	
Electrolytic	£57 10 0 to £58 10 0	
Best Selected Ingots, d/d Birmingham	£58 5 0	
Sheets, Hot Rolled	£89 0 0	
	Home.	Export.
Tubes, Solid Drawn (basis)	13¾d.	13¾d.
„ Brazed (basis)	13¾d.	13¾d.
BRASS—		
Ingots, 70/30, d/d Birmingham	£48 0 0	
	Home.	Export.
Tubes, Solid Drawn, 2/1 Alloy	12½d.	12½d.
„ Brazed	14¼d.	14¼d.
TIN—		
Cash	£260 15 0 to £261 0 0	
Three months	£259 5 0 to £259 10 0	
SPELTER—		
Cash	£20 13 9 to £20 16 3	
Three months	£21 0 0 to £21 1 3	
LEAD—		
Cash	£20 15 0 to £20 16 3	
Three months	£20 16 3 to £20 17 6	
Aluminium Ingots (British)	£100 to £105	

FUELS.

SCOTLAND.

	Export.
LANARKSHIRE—	
(f.o.b. Grangemouth)—	
Navigation Unscreened	20/6 to 21/-
Hamilton Ell	21/6
Splints	24/-
AYRSHIRE—	
(f.o.b. Ports)—Steam	21/- to 21/6
FIFESHIRE—	
(f.o.b. Methil or Burntisland)—	
Prime Steam	21/- to 21/6
Unscreened Navigation	20/6 to 21/6
LOTHIANS—	
(f.o.b. Leith)—Hartley Prime	19/6
Secondary Steam	19/-

ENGLAND.

SOUTH YORKSHIRE, HULL—	
B.S.Y. Hards	22/6 to 23/-
Steam Screened	20/6 to 21/-
NORTHUMBERLAND, NEWCASTLE—	
Blyth Best	21/6 to 23 6
„ Second	21/-
„ Best Small	18/6
Unscreened	21/- to 22/-
DURHAM—	
Best Gas	22/- to 22/6
Foundry Coke	40/- to 50/-

SHEFFIELD—	Inland.
Best Hand-picked Branch	28/- to 29/6
South Yorkshire	25/- to 27/6
Seconds	22/- to 24/-

SOUTH WALES.

CARDIFF—	
Steam Coals:	
Best Admiralty Large	25/- to 26/-
Best Seconds	25/- to 26/-
Best Dry Large	25/-
Ordinaries	25/- to 26/-
Bunker Smalls	19/- to 20/-
Cargo Smalls	17/6 to 18/6
Dry Nuts	27/- to 29/-
Foundry Coke	47/6 to 60/-
Furnace Coke	42/6
Patent Fuel	26/-
SWANSEA—	
Anthracite Coals:	
Best Large	38/- to 41/-
Machine-made Cobbles	41/- to 51/-
Nuts	40/- to 50/-
Beans	27/6 to 35/-
Peas	21/- to 26/6
Rubbly Culm	15/- to 16/9
Steam Coals:	
Large Ordinary	20/- to 25/-

FUEL OIL.

Inland consumption: contracts in bulk.

Exclusive of Government tax of 1d. per gallon.

Ex Ocean Installation.	Per Gallon.
Furnace Oil (0·950 gravity)	3¾d.
Diesel Oil	4½d.

French Engineering Notes.

(From our own Correspondent in Paris.)

Price Control.

THE committee for the supervision of prices was the creation of necessity when something had to be done to prevent workers from losing the benefit of higher wages through an inflation of living costs. No one can sell goods at more than a maximum price fixed by the committee, which only authorises advances when they are justified by increases of costs other than wages. While moderate advances have recently been allowed in selling prices on the home market of metallurgical and engineering products, coalowners are permitted to put up their prices by 20f. a ton, with an additional 3f. a ton for loading on barges. The idea that price control will preserve the margin between wages and living costs is futile, for the higher wages have only lately begun to produce their full effect upon transport, power, and other charges, and the franc devaluation continues to add to the cost of raw materials, so that these two factors alone have obliged the committee to comply with the demands of manufacturers for increases in selling prices. In present circumstances, a continued advance is inevitable, if makers are to be allowed to carry on their business, and, on the other hand, an inflation of prices, corresponding to further financial burdens on industry and the higher wages that are already foreshadowed in an attempt to keep pace with living costs, may dry up sources of consumption. There is a danger that quality may suffer in some products in order to keep within an acceptable price limit, but in others quality cannot be sacrificed, and it is with quality that French manufacturers hope to regain some of their foreign trade. Since June of last year, costs arising directly out of higher wages have increased by more than 80 per cent., and they continue to increase, and the control narrows down more and more the margin of profit which the maker must realise on the sale of his goods, because the committee puts the brake on selling prices instead of on production costs. This State intervention has introduced a new restriction in trade and industry that deprives manufacturers of their freedom to carry on business under normal conditions, and it has created a feeling of irritation in all branches of production, especially in agriculture, where the fixing of prices at below what producers regard as a legitimate level has driven them to the verge of revolt. The price control continues because, if producers were allowed to sell at prices commensurate with their production costs, the inflation would revive the wages' agitation in its most serious form. The Government is well aware that the price control system is a failure economically, and it was, in fact, intended originally to have only a limited application to prevent illicit profits, but its generalisation has had the effect of putting a check on all productive activity. It is for this reason that the Government has begun its extensive inquiry into the means of bringing about an industrial organisation that must start from the base, with a more practical adaptation of the forty hours' week and the equipment of works and factories in a manner to assist in increasing the production in order to compensate for the higher wages and fewer working hours.

The Bomb Outrages.

The destruction by bombs of the premises of two employers' associations in Paris has had a very unsettling effect upon the country, which has not been allayed by an attempt on Thursday of last week to destroy a packing case factory in Marseilles with incendiary bombs. The factory had been closed for a month on account of a strike, but as the strike had ended and arrangements were being made for a resumption of work, the outrage is the more inexplicable. All parties, including Communists, have expressed their indignation at these criminal acts, and as no trace of direct responsibility has yet been discovered, the mystery is still impenetrable. There is no means of reaching even a presumptive conclusion, except that the affair at Marseilles is believed to have been the work of recalcitrant strikers, in view of the fact that five men are said to have been seen to make their escape after the bombs had been thrown into the factory. The failure so far to trace anything to foreign anarchists, who could not have undertaken such a task in Paris on their own initiative, has widened the field of search to cover all revolutionary elements in the country. Whether or not it will be possible to fix the responsibility on any party, it is felt that the precautions now being taken against a repetition of these outrages offer a guarantee of safety in the future, but they have brought home to labour the possible consequences of extremist action in disputes that can only be settled within the law.

Labour and Shipbuilding.

In their annual report, the Ateliers et Chantiers de Saint-Nazaire (Penhoët) deal with the period of labour agitation and strikes, which created a situation that was seriously aggravated by the higher wages and holidays with pay, and more especially the forty hours' week, without the company being given time to adapt itself to the new conditions. This was the more serious for the shipbuilding industry, because owners have to purchase their ships at international prices, and the wide margin between French and international prices was widened, despite advancing prices abroad. While there are more orders in hand at Saint-Nazaire, they were taken at prices before the inflation, particularly the liner "Pasteur," which is to replace the "Atlantique," and this will entail adjustment with the Government. Another complaint in the report is the effect of the forty hours' week on skilled hands who have been trained by the company and were being absorbed by the State arsenals and factories and by the railways. The company continues to protest against this paradoxical situation. Reference is made in the report to the close collaboration of Penhoët with the Chantiers de la Loire, whose adjoining construction dock has necessitated their doing work in common, though each maintains its independence, and as Penhoët subscribed largely to the increased capital of the Chantiers de la Loire, the chairman of each company is on the board of the other.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

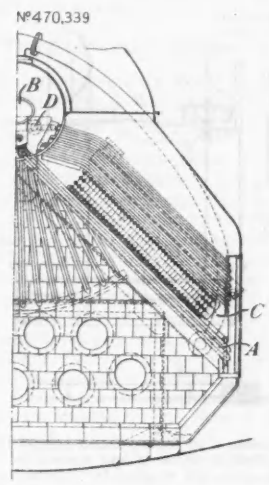
Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C.2, 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

STEAM GENERATORS.

470,339. February 7th, 1936.—WATER-TUBE BOILERS, W. Y. Lewis, 17, Woronzow-road, St. John's Wood, London, N.W.8.

In this boiler there is only one drum and the tubes are of the Field type. That is to say, each tube is closed at the end remote from the drum, but contains an inner tube which

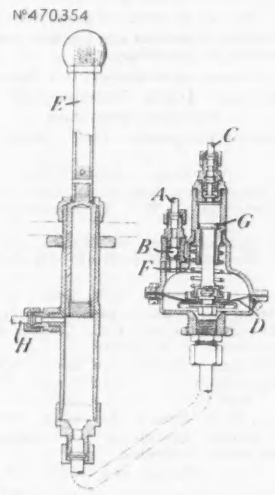


promotes circulation. The tubes are arranged to form an inverted V, and those A nearest to the furnace have their inner circulating tubes carried up into a trough B within the steam drum. There is a superheater C and then another bank of Field tubes of which the circulators are connected with a feed box D, also in the steam drum.—*August 9th*, 1937.

INTERNAL COMBUSTION ENGINES.

470,354. March 4th, 1936.—FUEL PUMPS, Exactor Control Company, Ltd., Mount Pleasant, Alperton, Middx, and W. H. Parkin.

This is a priming device for petrol engines, and is designed to prevent the engine from sucking fuel through it during normal working. The priming supply of fuel is given at A, through the non-return valve B, and is delivered to the engine through the



branch C. The fuel is forced to the engine by the upward deflection of the diaphragm D under the influence of pressure provided by the hand-operated plunger E. The diaphragm is returned by the spring F, which also closes the valve G. In order that fuel may not be sucked through the device when not wanted there is a breathing outlet at H, so that the spring F has full control of the diaphragm.—*August 13th*, 1937.

BATTERIES AND ACCUMULATORS.

470,240. March 5th, 1937.—ELECTRIC ACCUMULATORS, The Chloride Electrical Storage Company, Ltd., Exide Works, Clifton Junction, near Manchester.

This invention relates to electric accumulators of the alkaline type. The positive electrodes consist of pasted plates, such as are usually employed in alkaline iron and cadmium accumulators. The negative electrodes contain spongy zinc as the electro-active constituent, and to the zinc is preferably added a small amount of mercury, the paste carrier used being a metal which cannot be attacked by the electrolyte, preferably an iron-nickel alloy or one of these metals themselves. The electrolyte of this accumulator is formed by an alkaline solution, preferably potassium lye, which is saturated with boric acid to such an extent that the solution corresponds approximately to a metaborate solution. Porous supporting material plates of iron, nickel iron alloys, and nickel are mainly used. The zinc may be introduced into such plates in a variety of ways. For instance, zinc oxide may be dissolved in ammonia, the solution may be sucked into the porous plates, and the ammonia and any excess of water evaporated. This operation may be repeated several times, and thereupon the hydrate which has deposited in the pores of the plate may be reduced to the metal by electrolysis in alkaline solution. By, at the same time, dissolving cadmium hydrate in the ammoniacal zinc solution, it is possible to cause a spreading material to be simultaneously deposited. It is also possible to soak the porous metal plates with a zinc salt solution and then to separate off the zinc in an alkaline solution by a current. If such porous metal plates impregnated with metallic zinc be placed in water, a vigorous development of hydrogen will commence, as the extremely finely divided zinc oxidises particularly readily. It has been found that this evolution of gas (which, in the accumulator, leads to rapid self-discharge) can be almost entirely prevented if the porous metal plates be amalgamated before the introduction of the zinc. It ceases also when mercury is deposited on the zinc from a mercury salt solution.—*August 11th*, 1937.

ELECTRICAL APPLIANCES.

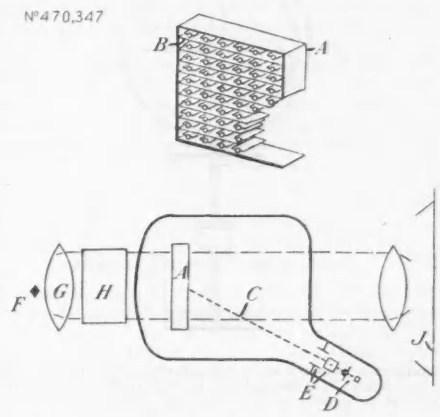
470,244. March 23rd, 1937.—INSULATION OF ELECTRICAL CONDUCTORS, The British Thomson-Houston Company, Ltd., Crown House, Aldwych, London, W.C.2.

In this specification a claim is made for the insulation of electric conductors by coating them with a varnish of polymerised acrylic acid derivative and then blowing on to it a coating of fibrous insulating material, such as cotton wool or asbestos, which is subsequently smoothed over by a brushing or combing process. It is hardly necessary to reproduce the sectional drawing of a conductor included with the specification.—*August 11th*, 1937.

TELEGRAPHS AND TELEPHONES.

470,347. February 13th, 1936.—TELEVISION APPARATUS, Baird Television, Ltd., and J. L. Baird, 58, Victoria-street, London, S.W.1.

This is a scanning, or reconstituting, apparatus for a television receiver. The essential feature comprises a grid A of minute cells containing a medium which is dichroic. That is to say, it will divide a light ray into an ordinary ray and an extraordinary ray and selectively absorbs one of these rays, so that ordinary light passed through such a medium emerges

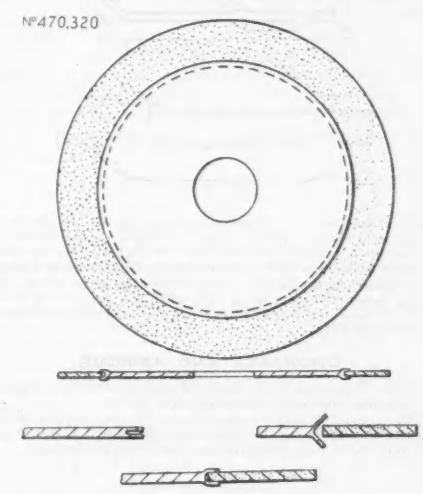


polarised. Such a medium is a colloidal suspension of dichroic crystals such as herapathite (sulphate of iodoquinine) or purpureocobaltchloridesulphateperiodide. Each of the cells of the grid contains an electrode A and is bounded by corresponding metallic walls B and two flat glass plates. Each of the electrodes has a small metallic button which protrudes through a hole in one of the glass plates. All these buttons are traversed by an electron beam C, emitted from D and guided by the deflector plates E. A source of light F is condensed at G, polarised at H, and is projected through the grid A on to the screen J.—*August 13th*, 1937.

MACHINE TOOLS AND SHOP APPLIANCES.

470,320. December 15th, 1936.—ABRASIVE WHEELS, *The Norton Grinding Wheel Company, Ltd., Welwyn, Herts.*

This is an abrasive wheel especially suitable for cutting-off operations. It comprises an annulus of abrasive material which is mounted on a sheet metal centre. The periphery of the centre



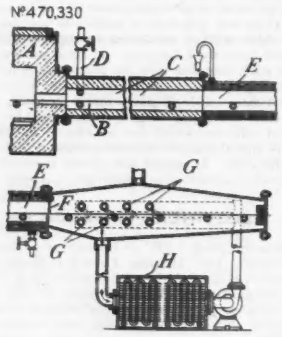
is split by any convenient means, among which are mentioned grinding wheels having a thickness of as little as 0·006in. The split is then opened out, the abrasive annulus put in place, and the forks of the split swaged over to hold the annulus securely.—*August 12th*, 1937.

FURNACES.

470,330. November 12th, 1935.—ANNEALING FURNACES, *A. Sadler, 44, Waterloo-street, Birmingham, 2.*

It is claimed that this furnace for producing bright annealed strip is much more compact than the usual arrangement. The illustration shows only the exit end of the electrically heated furnace A, while the elevation of the cooling end is broken for

convenience of illustration. The strip B first passes through a slow cooling chamber C, which is provided with a non-oxidising atmosphere at D. It then passes through a more rapid cooling

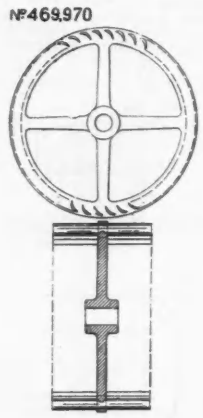


chamber E, which is water jacketed. Emerging through the gate F the strip passes through another chamber in which it is drenched by sprays G G of oil or water. The drenching liquid is collected and recooled in the cooler H.—*August 12th*, 1937.

PUMPING AND BLOWING MACHINERY.

469,970. March 20th, 1936.—FAN IMPELLERS, Matthews and Yates, Ltd., Cyclone Works, Swinton, Manchester, and W. Yates.

This fan impeller is made by assembling a ring of turbine

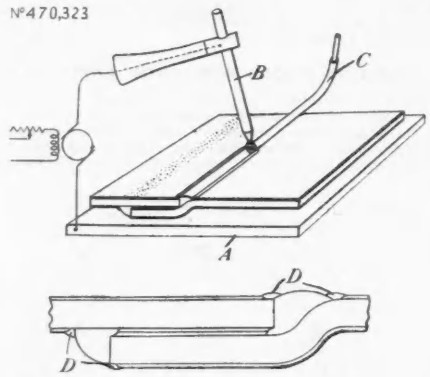


blading in a former and die casting a wheel around the centre of the blades. It is claimed that no bolts or rivets are required, and that the impeller is truly balanced.—*August 6th*, 1937.

WELDING.

470,323. January 28th, 1937.—WELDING AND WELD RODS THEREFOR, *Kodak, Ltd., Kodak House, Kingsway, London, W.C.2.*

This is a process for welding together sheets of galvanised sheet steel, which is said to leave the sheets of unimpared corrosion quality. The illustration shows a joggled lap joint being

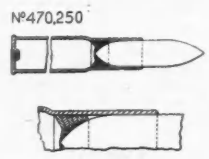


made on a table A by means of a carbon arc B. In the crevice of the weld there is placed a rod C comprising about 94·4 per cent. copper, 4·5 per cent. silicon, and 1·1 per cent. manganese coated with a layer of tin of a thickness of the order of 1/1000in. It is claimed that while the core provides the material for a good strong joint, the coating alloys with the galvanised surface of the stock as indicated at D D and prevents local corrosion.—*August 12th*, 1937.

ORDNANCE AND ARMOUR.

470,250. December 11th, 1935.—PROJECTILES, C. J. Coleman, 42, Old Gloucester-street, London, W.C.1.

The inventor explains that with the ordinary copper obturating ring on a projectile the ring wears rapidly as it passes through the gun barrel and consequently loses its gas-tightness. He



consequently uses a nest of cupped rings, as shown in the drawing, which expand as their edges wear away. It will be noticed that a streamlined bullet is illustrated, but this is not essential. The rings may be attached to the bullet, but are freed by the air wash when it leaves the gun barrel.—*August 11th*, 1937.

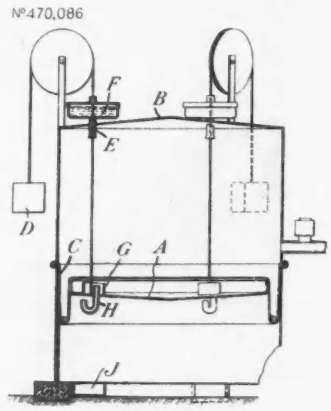
MISCELLANEOUS.

470,078. February 7th, 1936.—HIGH-GRADE LUBRICATING OILS, *G. W. Johnson*, 47, *Lincoln's Inn-fields, London.*

A Wietzer crude oil, for instance, topped to a residue of 78 per cent., is mixed with eight times its volume of liquefied propane and heated to 25 deg. Cent. The asphalt thus precipitated in an amount of 28 per cent. is separated and the solution of oil in propane heated to 95 deg. Cent. In this treatment 20 per cent. of an oil of high molecular weight is precipitated while 30 per cent. of a refined lubricating oil remains in solution. The layers formed are separated from each other and freed from solvent. The oil fraction of high molecular weight is then mixed at 50 deg. Cent. with from twice to three times its amount of crude cresol, whereby 60 per cent. of a refined fraction rich in hydrogen and 40 per cent. of a product poor in hydrogen are obtained. The two layers are separated from each other and freed from solvent. The refined fraction rich in hydrogen is then mixed with the 30 per cent. of refined lubricating oil. The mixture constitutes a motor oil having a viscosity index of from 85 to 90.—*August 9th*, 1937.

470,086. February 5th, 1936.—GASHOLDERS, J. H. Wiggins, 16, West Fifteenth-street, Tulsa, Oklahoma, U.S.A.

This gasholder is of the dry piston type, and has the merit of requiring no separate roof to keep out the weather. In it, the piston A forms the bottom, while the top B also acts as



roof. The piston is, of course, sealed against the sides of the holder by a flexible device C (not described). The piston is counterbalanced by the weights D. The ropes pass through stuffing-boxes E in the top, which are sealed by viscous oil in the pans F. Any oil which trickles down the ropes is collected at G, passes out by the siphons H, and drops into the trough J.—*August 5th*, 1937.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY TO SUNDAY, SEPT. 26TH.

ASSOC. OF SPECIAL LIBRARIES AND INFORMATION BUREAUX.—Annual Conference at Cambridge.

TO-DAY, TO SATURDAY, OCT. 2ND.

ENGINEERING AND MARINE EXHIBITION.—At Olympia.

SATURDAY, SEPT. 25TH.

JUNIOR INST. OF ENGINEERS.—Visit to Mogden purification works.

WEDNESDAY, SEPT. 29TH.

INST. OF LOCOMOTIVE ENGINEERS.—Inst. of Mechanical Engineers, Storey's-gate, S.W.1. Presidential address, Lt.-Col. F. R. Collins. 6 p.m.

NORTH OF ENGLAND INST. OF MINING AND MECHANICAL ENGINEERS.—Excursion to Rope Works of R. Hood Haggie and Son, Ltd.

THURSDAY, SEPT. 30TH.

INST. OF MECHANICAL ENGINEERS: YORKSHIRE BRANCH.—Visit to works of Reckitts, Ltd., Hull. "Excavating Machinery for Flood Prevention," H. Beaumont.

INST. OF METALS: BIRMINGHAM LOCAL SECTION.—James Watt Memorial Institute. "Wire Drawing," Professor F. C. Thompson. 7 p.m.

THURSDAY, SEPT. 30TH, TO SATURDAY, OCTOBER 2ND.

NATIONAL SMOKE ABATEMENT SOC.—Philosophical Hall, Leeds. Ninth annual conference.

FRIDAY, OCT. 1ST.

INST. OF PRODUCTION ENGINEERS.—British Industries House, W.1. Annual general meeting. "Practical Research in Production Engineering," Dr. G. Schlesinger. 7.15 p.m.

INST. OF SANITARY ENGINEERS.—Hill's Restaurant, Caxton House, Tothill-street S.W.1. Opening sessional meeting. 7.30 p.m.

MONDAY, OCT. 4TH.

STEPHENSON LOCOMOTIVE SOC.—King's Cross Station, N.1. "The Control of Train Speeds on the G.W.R.," C. T. Roberts. 6.30 p.m.

TUESDAY, OCT. 5TH.

INST. OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND.—39, Elmbank-crescent, Glasgow. Presidential address.

THURSDAY, OCT. 7TH.

INST. OF ELECTRICAL ENGINEERS: NORTH MIDLANDS CENTRE.—Hotel Metropole, Leeds. "The Examination and Recording of the Human Electro-cardigram by Means of the Cathode Ray Oscilloscope," Dr. D. Robertson. 7 p.m.

INST. OF LOCOMOTIVE ENGINEERS.—Inst. of Mechanical Engineers, Storey's-gate, S.W.1. Informal meeting. 6 p.m.

RAILWAY CLUB.—Royal Scottish Corporation Hall, Fetter-lane, E.C.4. "Railway Developments," W. A. Willcox. 7.30 p.m.

FRIDAY, OCT. 8TH.

INST. OF CHEMICAL ENGINEERS.—Joint meeting with other societies in Chemical Lecture Theatre, Armstrong College, Newcastle-on-Tyne. "The Influence of Particle Size in the Processes of Fuel Technology," Dr. P. O. Rosin. 7.45 p.m.

INST. OF MECHANICAL ENGINEERS.—Storey's-gate, S.W.1. Informal meeting. "The Advantages of Group Drives," J Hornsby. 6.30 p.m.

INST. OF METALS: SHEFFIELD LOCAL SECTION.—Non-Ferrous Section of the Applied Science Department of the University, St. George's-square. "Some Recollections of the Nickel Industry," W. R. Barclay. 7.30 p.m.

JUNIOR INST. OF ENGINEERS.—39, Victoria-street, S.W.1. "Development of the Pressure-ignition Engine," H. G. Pussey. 7.30 p.m.

MONDAY, OCT. 11TH.

INST. OF METALS: SCOTTISH LOCAL SECTION.—Institution of Engineers and Shipbuilders in Scotland, 39, Elmbank-crescent, Glasgow. Chairman's address, H. Brown. 7.30 p.m.

TUESDAY, OCT. 12TH.

INST. OF ELECTRICAL ENGINEERS: NORTH MIDLAND CENTRE.—Hotel Metropole, Leeds. Chairman's address, J. G. Craven. 7 p.m.

INST. OF MARINE ENGINEERS.—85, The Minories, E.C.3.—"Some Operating Results of Diesel-electric Propulsion," G. T. Shoosmith. 6 p.m.

INST. OF METALS: NORTH-EAST COAST LOCAL SECTION.—Electrical Engineering Lecture Theatre, Armstrong College, Newcastle-upon-Tyne. Chairman's address, C. E. Pearson, M. Met. 7.30 p.m.

INST. OF METALS: SWANSEA LOCAL SECTION.—At the Y.M.C.A. Chairman's address, "The Application of Science to the Non-ferrous Industry," Harry Davies. 7.30 p.m.

WEDNESDAY TO FRIDAY, OCT. 13TH TO 15TH.

INST. MECHANICAL ENGINEERS.—Storey's-gate, S.W.1. General discussion, "Lubrication and Lubricants."

THURSDAY, OCT. 14TH.

INST. OF MECHANICAL ENGINEERS: YORKSHIRE BRANCH.—Hotel Metropole, Leeds. Discussion, "The Use of Steam for Power and Industrial Purposes." 7.30 p.m.

INST. OF METALS: BIRMINGHAM LOCAL SECTION.—James Watt Memorial Institute. Joint meeting with the Iron and Steel Institute. 7 p.m.

INST. OF METALS: LONDON LOCAL SECTION.—Rooms of the Society of Motor Manufacturers and Traders, Ltd., 83, Pall Mall, S.W.1. Chairman's address, H. J. Gough. 7.30 p.m.

ROYAL AERONAUTICAL SOC.—Inst. of Mechanical Engineers, Storey's-gate, S.W.1. "The Hafner Gyroplane," R. Hafner. 6.30 p.m.

FRIDAY, OCT. 15TH.

INST. OF MECHANICAL ENGINEERS.—Connaught Rooms, Great Queen-street, W.C.2. Annual dinner.

JUNIOR INST. OF ENGINEERS.—39, Victoria-street, S.W.1. "Smoke Abatement," E. H. Sidwell. 7.30 p.m.

NORTH-EAST COAST INST. OF ENGINEERS AND SHIPBUILDERS.—Bolbec Hall, Newcastle-on-Tyne. Presidential address by Professor C. J. Hawkes. Time not stated.

THURSDAY, OCT. 21ST.

DIESEL ENGINE USERS ASSOC.—Caxton Hall, S.W.1. "The Design of Elastically-supported Foundations for Reciprocating Engines," R. Klopstock. 5 p.m.

INST. OF MARINE ENGINEERS: JUNIOR SECTION.—East Ham Technical College. "Mechanical Stoking of Marine Boilers," G. T. Marriner. 7.30 p.m.

ROYAL AERONAUTICAL SOC.—Inst. Mechanical Engineers, Storey's-gate, S.W.1. "Practical Airscrew Performance," F. M. Thomas. 6.30 p.m.

FRIDAY, OCT. 22ND.

INST. OF MECHANICAL ENGINEERS.—Storey's-gate, S.W.1. General meeting and presidential address. 6 p.m.

JUNIOR INST. OF ENGINEERS.—39, Victoria-street, S.W.1. "Sewage Raising by Means of Pneumatic Ejectors," H. A. Hatt. 7.30 p.m.

FRIDAY, OCT. 29TH.

JUNIOR INST. OF ENGINEERS.—39, Victoria-street, S.W.1. "Submarine Telegraph Cables, their Construction and Maintenance," H. G S. Trowbridge. 7.30 p.m.

LAUNCHES AND TRIAL TRIPS.

KAIKOUR, cargo ship; built by Alexander Stephen and Sons, Ltd., to the order of New Zealand Shipping Company, Ltd.; dimensions, length 440ft., breadth 59ft., depth 39ft., to carry 5900 tons. Engines, four-cylinder, opposed-piston; constructed by John Brown and Co.; launch, September 7th.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

THE WESTMINSTER TOOL AND ELECTRIC COMPANY, Ltd., informs us that it has changed its name to Westool, Ltd. There is no change in the management or address, which is still Westool Works, Putney Bridge-road, S.W.15.

DORMAN AND SMITH, Ltd., Ordsal Electrical Works, Salford, inform us that Mr. H. G. Baggs has retired after forty-five years of service with the company, during the last seven years of which he was chairman. The new board consists of Mr. Thomas Atherton (chairman), Mr. Richard Amberton, and Mr. J. Noel Haworth, with Mr. R. G. Dale as secretary.

MR. W. S. BURN has resigned his position as designer and chief of the oil engine department of Richardsons, Westgarth and Co., Ltd., Hartlepool, and has taken up permanent residence in London as an independent consultant, specialising on oil engine work, with an office at 9, Camomile-street, Bishopsgate, E.C.3. He will still be associated with Richardsons, Westgarth and Co., as a consultant on the R.W. oil engine, and also with their subsidiary company, the Marine Oil Engine Development Syndicate, Ltd., of which he is a director.

CONTRACTS AND ORDERS.

The Editor is always happy to print short announcements of contracts and orders in this column provided they are sent to him in time to have news value and that they are likely to interest readers.

J. BLAKEBOROUGH AND SONS, Ltd., Brighouse, Yorkshire, have received a contract for the valves and ironwork for the Derwent Valley Water Board's new Ladybower reservoir. The contract includes equipment for twin valve shafts, with 36in. diameter, hydraulically operated draw-off valves and manual guard units, also Larner-Johnson streamline discharge valves in the control house, and Larner-Johnson streamline valves for compensation water control. The value of the contract exceeds £30,000.